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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF ENTOMOLOGY.
BULLETIN NO. 32.

REPORTS

OF

OBSERVATIONS AND EXPERIMENTS

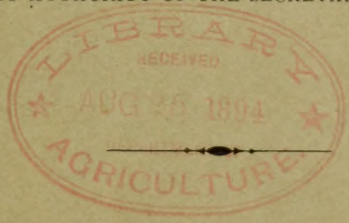
IN

THE PRACTICAL WORK OF THE DIVISION,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

(PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE)



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., April 14, 1894.

SIR: I have the honor to transmit for publication Bulletin No. 32 of this Division. It comprises the reports of the field agents of the Division for the past year (1893), a summary of which has been included in my annual report.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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REPORTS OF OBSERVATIONS AND EXPERIMENTS IN THE PRACTICAL WORK OF THE DIVISION.

INTRODUCTION.

For some years past it has been the custom, with the approval of the Secretary of Agriculture, to bring together in a single bulletin, at the close of each season, the formal reports of the field agents of the Division; thus, Bulletins 22, 23, 26, and 30 of the Division comprise the reports of the field agents for the years 1889, 1890, 1891, and 1892. This present bulletin is a continuation of this series. All of the field agents represented in Bulletin 30, with the exception of Mr. Larrabee, were continued through the year 1893. All, however, were discontinued February 15, 1894, and are no longer connected with the Division, with the exception of Mr. Coquillett, who has been called to Washington and is now an office assistant.

Mr. Bruner has reported in the main on the observations made upon injurious locusts, and judging from these observations there is no reason to fear serious injury during the year 1894. The occurrence in special abundance of several injurious insects, including the army worm and the wheat-head army worm is reported, and a number of new insect injuries are mentioned.

Mr. Coquillett's report consists principally of a somewhat detailed account of several different kinds of leaf-eating caterpillars which attack fruit trees and nut trees in California. To this he adds a section on arseniureted and sulphureted hydrogen as insecticides.

Mr. Koebele presents a few additional observations upon the subject of the hop plant-louse in the northwest, and some additional facts regarding the latest importation of beneficial insects from Australia.

Miss Murtfeldt gives a general summary of the injurious insects of Missouri for the year 1893.

Prof. Osborn, in a like way, reports upon the injurious insects of Iowa for the season, and includes some important observations on the hatching of the eggs of the horse bot-fly.

Dr. Packard reports the almost complete recovery of the regions in Maine ravaged in 1878–'87 by the spruce worm, and he includes a number of new observations upon insects injurious to forest trees.

C. V. R.

REPORT ON INJURIOUS INSECTS IN NEBRASKA AND ADJOINING DISTRICTS.

By LAWRENCE BRUNER, *Special Field Agent.*

LETTER OF SUBMITTAL.

LINCOLN, NEBR., *November 3, 1893.*

SIR: I submit herewith a short report upon my investigations among the injurious insects of Nebraska and adjoining districts during the past summer. While these pests have not been generally numerous and destructive over the region assigned me, a few species from among the hosts of these creatures that are ever present have been sufficiently abundant to commit injury to the crops attacked and to require special attention on the part of the entomologist and agriculturist. Some of my time has also been given to a further study of destructive locusts and allied insects belonging to the order Orthoptera, in which I have been especially interested for some years. For this purpose three separate trips were made into quite distinct regions, viz, one to Colorado for the purpose of investigating a local locust outbreak about the town of Grand Junction, a second to western Nebraska and eastern Wyoming to examine into a reported appearance of the Rocky Mountain locust, and, lastly, a short tour of inspection through the eastern and central parts of Nebraska for the purpose of ascertaining exactly how numerous and extensive were the injuries caused by the "native" species of locusts that had been reported as committing havoc with various garden truck, small trees, grape-vines, and also in some instances field crops.

Many of the notes made on other insects than locusts, and in fact some of the latter also, were obtained in connection with work carried on at the University of Nebraska or while engaged in field work for this institution. These latter are submitted herewith as of some possible value to the general public aside from citizens of the State.

Very respectfully, yours,

LAWRENCE BRUNER.

C. V. RILEY,
U. S. Entomologist.

LOCUSTS OR "GRASSHOPPERS."

The past summer again has been noted as one in which the various species of indigenous locusts were present in overwhelming numbers over a large area of country. The injuries wrought by these insects were, therefore, great and widespread. Reports bearing on the subject were received from a number of correspondents located in this and adjoining States. The newspapers also contained like reports, from all of which it becomes quite evident that something definite in the

way of remedying the evil must be done soon if we would expect to escape future ravages from this source. Many of the common species, like the red-legged locust (*Melanoplus femur-rubrum*), the two-striped locust (*Melanoplus bivittatus*), and the differential locust (*Melanoplus differentialis*), and others of like nature, are becoming more and more reconciled to "civilized ways" each succeeding year, and hence are better enabled to withstand these conditions than are others. This being true, they increase proportionately as the area embracing the conditions under consideration enlarges. Other influences, of course, also either favor or retard the increase of these particular species, as they do allied forms; but these influences seem to have less to do with the matter in their case than in that of the majority of species. They are the "hardy forms" of the family, and are capable of adapting themselves in their life struggle to a greater amount of variation in climate, altitude, and surface configuration.

Several trips were made during the summer in connection with the study of our destructive locusts. Besides the time thus spent, some attention was given the subject here at home. One of these trips was made during the latter part of June to western Colorado, where I went to examine into locust injuries in and about Grand Junction. Although I reported at the time, I submit the following account of this trip for your inspection:

A Report on Locust Injuries in the Vicinity of Grand Junction, Colo.— At the request of the Board of Trade of Grand Junction, I visited that place during the month of June to examine into a plague of locusts that were engaged in devastating the region about that city. After spending a week here I found the conditions to be about as follows: About four years ago it was observed that grasshoppers were unusually abundant on a piece of waste land near the Grand River, a little south of the town of Fruita, which is situated about 12 miles west of Grand Junction. As the 'hoppers had plenty of food and were not destroyed by parasites or disturbed by the settlers or by birds to a sufficient extent to reduce their numbers, and having suitable places for the deposition of their eggs, the result is plain. The winter following the egg-laying reported was favorable, and the following spring, being likewise favorable to the young, resulted in the spreading of the pest to several of the surrounding farms, where they did some damage to crops and orchards. Again nothing was done to diminish their numbers or to prevent their injuries or their spread to new ground. The season was also favorable to their development, egg-laying, and spreading. The opening of the third year came, and in course of time the young hatched and began their work upon the crops over a greatly extended area. Their injury was quite extensive, in fact, and comprised both field crops and orchards. This year many thousands of dollars' worth of property was destroyed by them. The orchards in particular suffered from their depredations. As the principal product of the region is fruit, the destruction of fruit

trees was greatly felt by the settlers who happened to lose by their attacks. One orchard alone is reported to have suffered to the extent of $25,000. That this estimate was none too great I can attest from personally having visited and examined it. The orchard in question is of 80 acres in extent and composed of thrifty trees, all of bearing size. Fully one-half of the trees were destroyed by the locusts, which came by the millions from adjoining fields of alfalfa. They ate off the leaves and even stripped the smaller twigs of their bark. A great many other orchards were more or less completely destroyed by the pest last year. Even with all this amount of injury going on about them, the inhabitants did but little toward protecting themselves, and what little fighting they did do was undertaken so late in the year that it did comparatively little good even in the line of preventing egg depositing. The warfare did not begin until after the 'hoppers had attained their wings and were spreading out over the region preparatory to egg-laying. At this time they had mostly left the fields of alfalfa and grain and were nearly all in the trees composing the various orchards of the region. Here they remained upon the twigs and branches, feeding upon the leaves and tender bark of the new growth. In this situation it was next to impossible to dislodge them or get at them with a remedy. Some bran and arsenic was used by a few of the settlers in fighting the pest, but this was handled so carelessly in many instances that not only were domestic fowls and an occasional larger animal destroyed, but also nearly all of the native birds of the region that occasionally add to their insect diet other food were killed. In fact, the only good feature connected with the use of the bran-arsenic remedy in this particular instance was the destruction of many rabbits. These latter were killed by the hundreds and pretty well exterminated in the immediate vicinity of the orchards where the remedy was used.

The present year, the fourth in which these insects have been present in this region, I chanced to visit the locality about a week before the mass of 'hoppers had attained their growth. I was therefore in time to do some good for the residents by suggesting and showing them a more profitable and, at the same time, practical method of warfare suitable to the particular occasion, viz, the "hopper-dozer," or kerosene pan. It was ascertained that the majority of the insects were still confined to the edges of alfalfa and grain fields, or else were to be found amongst the rank vegetation growing along the edges of irrigating ditches and over such grounds as were more or less frequently watered by the waste from these ditches. In such localities it was seen that the most practical remedy that could be employed at this time was the "dozers." Accordingly several of these machines were ordered made, and meetings of the farmers and fruit-growers and other interested parties called for the purpose of discussing the subject preparatory to attacking the foe. At these meetings, held in both Grand Junction and Fruita, addresses were delivered outlining the various methods that have been

used at various times in the past in different countries and under divers conditions in fighting the locust pests of the world. In connection with the remarks made, charts were exhibited showing the differences among the species committing these injuries against which relief had been sought. Both the practical remedies, or such as can be applied with a saving, and the impractical remedies, or such as cost more to apply than would be the value of the crops intended to be saved, were described at some length. It is needless to say that I favored the practical remedies, although there were many among the audiences who insisted upon the adoption of some remedy where there would be little or no outlay of labor. Nevertheless the "practical" methods were insisted upon by me since the people were not overburdened with cash to such an extent that they could afford to go into a series of doubtful experiments at this late date of the trouble.

Every circumstance seemed to favor the use of the hopper-dozers at this time. Prior to my arrival the citizens of Grand Junction had secured a 10,000-gallon tank of crude petroleum for use in destroying the 'hoppers. This, as I afterwards ascertained, was intended to be used for pouring into the irrigating ditches and allowing it to spread over the country so as to come in contact (?) with the insects which it was intended to destroy. In my addresses I insisted that this would only be throwing the material away and would also destroy the vegetation wherever the oil reached, and that the locust would be mostly left unharmed. We tried the oil in the 'hopper-dozers and were surprised at the results. It worked much better, if possible, than the refined oil, and its cost was so very much less, being only 4 cents per gallon delivered at Grand Junction, that its use in this connection could be highly recommended. The comparative thickness made it more desirable because of its remaining in the pan to better advantage. It could even be cheapened by adding water to the oil in the pan on the dozers.

There were several species of locusts concerned in the depredations in and about Grand Junction, as well as at other points in the surrounding regions of Colorado. I found *Melanoplus atlanis*, *M. bivittatus*, and *M. differentialis* in the fields of the region examined. There were also several other species very numerous in the valley and upon the surrounding hills wherever the vegetation was of sufficient size to support them. One was an undescribed species of Pezotettix, as these insects have been classed by American writers, somewhat resembling *M. turnbulli* Thos., only with very short and rounded tegmina. Like *M. turnbulli*, it seems to be confined chiefly to species of the Chenopodiaceæ, of which the region contains many forms. It is especially fond of the greasewood (*Sarcobates vermicularis*). Peculiar enough was the fact that on my arrival much of the preparation for defense that was then under way was for the destruction of this Pezotettix, that did none or very little of the injury that had thus far occurred in the valley. I have proposed for this species the name *Pezotettix cheno-*

podii, and have furnished for publication in *Insect Life* a more detailed description than is here given.

Whether or not my visit to the region in question resulted in any good to the settlers I can not say, for I have not heard from there up to the date of this writing. If the instructions which I gave and insisted upon being carried out were followed the valley could be practically freed from the pest.

In estimating the cost for the extermination of the plague in this particular region, I believe that it could have been done with an expenditure not to exceed a couple of thousand dollars in money. Of course, the labor necessary for the extermination would be quite an item were it performed solely for the destruction of the 'hoppers without any regard to the saving of crops, and if not done by the settlers themselves upon their own and adjoining lands. Some of these figures were given to the public in my talks above alluded to.

In closing my remarks concerning this visit to Grand Junction, I wish simply to add that nature has made the region one of the very best fruit districts in the country. Climate is favorable, but few insect pests have been introduced from abroad, and these cannot live in the changed conditions of the arid climate belonging to the country. Few of the native insects can ever become injurious on account of the differences in the food-plants that this change would entail. Lastly, the grasshopper plague of the past few years is due entirely to carelessness on the part of the settlers themselves, and a repetition of such an occurrence can be prevented by a little watchfulness on their part. A little care in the way of cleaning up about the waste lands lying along the ditches will be all that is necessary.

West Nebraska and Wyoming Trip.—On the 23d of August I left Lincoln for the western part of this State and eastern Wyoming to examine into the reported locust injuries in that section of the country. Stops were made at Sidney, Pine Bluffs, Cheyenne, and the country lying at the headwaters of Pole and Crow creeks. Over this entire scope of country the various "native species" of Acridians were exceedingly numerous—much more so than ordinarily—and any one who has collected these insects here knows what such an assertion means. Judging from the collections made at each of the localities visited, I have no hesitation in making the statement that fully one-half of the species common to the country embraced were injuriously numerous. Some of these had never before been observed by me to occur so plentifully. While but little farming is done in this region, the injury was nevertheless much felt by the settlers. The ranges were much reduced in value by these insects, which must have devoured fully one-half of all the grasses and other forage plants growing upon them. In many places the vegetation had been eaten so closely that a sheep would have had a hard time to feed upon the remnants.

In settled districts and where irrigating is resorted to remedies can be suggested, but upon the high, dry plains of western Nebraska and

the adjoining portions of Colorado and Wyoming it is impossible to destroy these locusts by any artificial means known to me. Climatic conditions alone must be depended upon for remedying the evil, since the scope of country that would necessarily have to be covered is too great to think of stamping out the pest artificially.

Rocky Mountain or Migratory Locust.—The Rocky Mountain or migratory locust (*Melanoplus spretus*) has not been reported from any point in excessive numbers during the past summer so far as I am at present aware. Still it seems to have been sufficiently common over portions of the subpermanent region to warrant our watching its movements. On or about the 18th of August it was reported that grasshoppers in considerable numbers were seen in the air at West Point, this State. Although it is not definitely known to just what species these hoppers belonged, they were without doubt stragglers of the present species, since at about the same time it occurred in moderate numbers here at Lincoln and several neighboring places. In fact, it has been noticed by me both in the air and on the ground several times during the summer, as it was also last summer. At no time, however, was it observed in sufficient numbers to do perceptible injury to crops or other vegetation, nor were the insects seen to deposit eggs. It did not appear among the species that caused the observed and reported damages during the season.

Injuries from "Native" Locusts.—Much injury was done during the summer by different species of our native locusts that have been very common at a number of localities in this and adjoining States. Here at Lincoln we were obliged to fight them upon the experimental farm; and from a field of oats of about 30 acres in extent at least 50 bushels of winged locusts were captured with a hopper-dozer. They were hatched upon waste land adjoining the farm, and during the dry, hot weather of August left the weeds and moved into the more inviting fields. Numerous reports of similar injuries reached me from nearly every portion of this and adjoining States where farming was carried on extensively. The species concerned were the common ones usually engaged in such depredations in this central region, viz, the red-legged, the two-lined, the differential and the lesser migratory. In some localities all, in others only one or two, of these were concerned in the injuries. At different localities different ones were present in greatest force.

As stated above it is quite evident that if the losses occasioned by these insects do not soon cease, something will have to be done to prevent their further depredations.

OTHER INSECTS.

The Army Worm.—This year has been noted in Nebraska as one in which the army worm (*Leucania unipuncta*) was exceedingly abundant and did much injury to crops in many of the western, northwest-

ern, and northern counties. Millet appeared to suffer most, although late oats and corn in a few instances were injured to some extent.

One of these regions, viz, Ordai, in Valley County, was visited for the purpose of studying the insect in its work upon the crops. In this section of country several fields of millet had been almost entirely destroyed by the worms about a week prior to my visit. From the millet the worms moved into adjoining corn fields, at the edges of which they were fought in two or three instances by means of deep furrows in which logs were dragged backward and forward. Many of the larvæ or caterpillars had already entered the ground and transformed to chrysalids; but still others remained in the fields hidden away under garbage of all kinds, or crept about on the ground. Nearly all of these contained the eggs of Tachina flies upon their heads and thoracic joints. Flying and walking about the infested fields were large flocks of Bartram's sandpiper, red-winged blackbirds, sparrows, meadowlarks and several other birds that had been attracted by the rich food supply. These, together with the dipterous parasites, predaceous ground-beetles, and several wasps, had, I was informed at the time, destroyed more than three-fourths of the pests, thereby illustrating the value of these creatures in keeping injurious insects in check.

Reports also reached me of the presence of this insect in hurtful numbers at the following localities: In Dixon, Holt, Jefferson, Custer, Valley, and several other counties not definitely stated.

The Wheat-head Army-Worm.—This year for the first time I have seen the larva of *Leucania albilinea* to recognize it. While running the hopper-dozer on the experimental farm in capturing destructive locusts, numerous specimens of the caterpillars of this insect were found mingled with the dead hoppers in the kerosene-oil pans. They were clinging to the stems of the grain and were knocked down by the machine as it was dragged through the field. Although quite plentiful, the larvæ did not appear to do any appreciable injury in the field of oats that had been planted to cut for hay. No attempt was made to breed parasites from the insect, although some specimens were seen to contain eggs of some dipteron upon the thoracic segments and head.

The Fall Web-worm.—This insect was again quite prominent among the insect enemies that were present in cities and towns during the summer. Especially was this true with respect to its first brood. In the cities of Omaha and Lincoln it appeared in large numbers, particularly in the former city, where it stripped and covered the branches of most of the box-elders and some of the other shade trees with its unsightly webs. So alarmed about its continued presence and further injuries were many of the citizens that they cut down the trees "to save them." In fact, the moths for the second brood issued in large numbers, laid their eggs and died. These eggs hatched, and the situation certainly appeared quite critical. For some reason the greater proportion of the caterpillars of this second brood died or were destroyed

before they had become half grown. Whether their demise was due to disease or to the attacks of certain predaceous and parasitic insects, or both, I have not learned. That they disappeared at this particular stage of their growth remains a certainty, as I have been assured by several correspondents who were greatly interested in the subject and who watched them very closely. In this city also this second brood of caterpillars was less numerous than the first, and, as in Omaha, they dwindled from time to time so that comparatively few matured.

The Eight-spotted Forester.—During July reports of injury by this insect to vineyards reached me. About the second week of the month a few of the grape-growers in the vicinity of Omaha became so alarmed about the ravages of the larvæ of this moth that they asked me to visit their vineyards at their expense. I did so and found that the caterpillars had been quite numerous and done much damage by devouring the foliage in several of the smaller vineyards. At the time of my visit (July 13) most of the caterpillars had disappeared; but such as remained were much infested with the eggs of some Tachina fly. As many as four to eight of these eggs were frequently found upon a single caterpillar. These parasitic flies had evidently been quite abundant during the reign of the caterpillars.

Some spraying with Paris green and London purple was done with beneficial results; but most growers "trusted in Providence," and in this instance, at least, fared fully as well as did those who "fought."

The Stalk-borer.—While investigating the ravages of the eight-spotted forester about Omaha much injury caused by the common stalk-borer (*Gortyna nitela*) was also observed. The larvæ of this insect seemed exceedingly common, and were working on sweet-corn, tomatoes, egg-plant, etc., many of the stalks of which were bored into, causing them to die. In some instances two, occasionally even three, of the caterpillars were found working in a single stalk. It is needless to state that considerable injury resulted from their attacks. As a remedy I suggested the collecting and burning of all injured stalks containing larvæ.

Unknown Lepidopterous Larva boring in Stalks of Corn.—Late in August a specimen of the work of some lepidopterous larva boring in the stalks of corn was received from Mr. H. S. Smith, living near Pender, this State, with the accompanying letter:

"I today send you by mail an insect that is working on the corn to a considerable extent, and that is at least new to me. It generally works about the second joint above ground. Have now mostly left the corn—not over one in twenty still in stalk."

In a second letter (September 5) he wrote: "Would say that the insects wanted have almost entirely left the corn. Only succeeded in finding two, which I send you. Found one that was being eaten by a white maggot that looks like the larva of the common 'bluebottle.' There

are always two holes in the cornstalk, one at each end of where it has bored the inside out. The injured stalks break off in wind storms."

The insects had entered the chrysalis stage when received, so that the larva is unknown to me. It would appear from what Mr. Smith writes that some of the larvæ leave the stalks to transform, while others do not. At any rate, its comparative abundance and boring habits would indicate that we have in this insect a quite dangerous corn pest. It certainly will require additional study before we are entirely acquainted with it in all of its changes and life-history. The only encouragement that I can now offer is the presence, apparently, of a dipterous parasite in the "white maggot," mentioned by Mr. Smith.

Swarms of a Noctuid Moth.—Large swarms of Noctuid moths appeared almost simultaneously at many widely separated points in Nebraska and adjoining regions during apple-blooming time, and a number of letters were received concerning them. Many of my correspondents seemed to think they were the codling moth (*Carpocapsa pomonella*) that had issued somewhat prematurely and were simply waiting for the proper time for oviposition. Consequently, their having taken alarm could not be wondered at. Judging from the material accompanying some of the letters, it is supposed that the swarms were chiefly made up of a single species of cutworm moth (*Chorizagrotis introferens*), although several other species were represented in some localities. The material received varied greatly in size and markings, as could be seen even from the much-rubbed specimens in question. At the time nothing was thought of the matter, and none of the insects were saved. A little later, when the Entomologist requested an investigation of the larval stages of this species, with its life-history and food-habits, the swarms of moths had disappeared, their going having been apparently as sudden and complete a mystery as was their coming. A careful search by myself and several students at different places where moths had been very plentiful during the invasion failed to reveal any larvæ in uncommonly great numbers; and all requests by letter among such correspondents as were addressed on the subject were just as futile.

It is greatly to be regretted that no solution of this insect's life-history and food-habits were made when such apparently good opportunities were offered for the purpose. Was not this one of those peculiar cases of an ordinarily rare insect gathering in countless numbers and migrating to regions new that we sometimes hear about or have occasion to record? Were not the swarms of moths gradually brought together and wafted into the region by some peculiarly favorable winds from the southwest? I can imagine no other solution of this problem. It seems identical with the case of the *Aletia xylina*, which often appears over much of the region lying to the far north of its natural range, and away from all of its known food-plants.

SUGAR-BEET INSECTS.

Tanymecus confertus as a Sugar-beet Enemy.—Early in the season information reached me of considerable injury to young sugar beets at Ames, this State. With the report were inclosed specimens of the beetle known by the above name. A visit to the infested fields a few days later resulted in confirming what had been claimed by my informant, viz, that this insect was present in large numbers upon a certain field of about twelve acres in extent, the greater portion of which had been completely defoliated. Investigation convinced me that the insect, although quite a general feeder, was more partial to several of the weeds growing in the field with the beets and only attacked the latter when the others had been devoured. Chief among the weeds thus attacked was the common cocklebur (*Xanthium strumarium*). Such other weeds as *Chenopodium alba* and *Polygonum* sp. were also eaten.

At the time of my visit the insects were mating, and as the cocklebur appeared to be their first choice as a food plant, it was surmised that that was the plant which naturally attracted the insect in such large numbers, and that the beet was only attacked after the other had been exhausted. Further investigations revealed the fact that last year, and in all probability for several previous years, the same field and several of the adjoining tracts of land had been allowed to grow up with cockleburs. This leads me to conclude that the insect had bred upon or within this plant in such numbers as to become a pest the present year when most of the weeds upon which they fed through choice had been destroyed. Later the insects dispersed and nothing further has been heard of them as a beet enemy.

Numbers of the beetle were carried home with me and kept confined in a fruit jar with several plants as food. In all instances the cocklebur was totally destroyed before the others were attacked.

Eggs were laid by the insects indiscriminately upon the sides and bottom of the jar, as well as upon the vegetation placed in the jar for food. These, however, did not hatch, as they were evidently abnormally placed. Here would have been a splendid opportunity of ascertaining something of the life-history, had I been provided with breeding facilities for rearing and studying its various stages. My limited room here prevented such a study and the opportunity was lost to me for this year at least.

Where the insects attacked the young beets a sprinkling with London purple was said to be effective in checking their injury, but whether by killing or driving the insects away was not reported.

The Juniper Bark-borer.—An insect that is of special interest to us in this part of the country where but few evergreens grow naturally, is the one known as the juniper bark-borer (*Phlœosinus dentatus*) on account of its usual mode of attack upon our red cedar (*Juniperus virginiana*). During the year this insect was called to my attention by Mr. R. Harvey, of St. Paul, through the secretary of the State board of agriculture. It

appears that it has been brought into this particular region by means of a shipment of cedar posts and, escaping, has found the trees upon the lawn of Mr. Harvey. These trees being smaller than the trees usually attacked by this insect, the mode of attack was necessarily changed to conform with the conditions. Instead of working under the bark by running its galleries between the wood and bark, it attacked the smaller twigs and limbs where it entered at the axils of these with the still smaller twigs, reminding one of the attacks of *Amphicerus bicaudatus* upon apple trees.

I remember another case, something similar to the present, where the shipment of posts of this tree was the means of introducing a number of specimens of the cedar borer (*Hylotrupes ligneus*). Some of the mature beetles escaped and found a tree growing in the lawn of a resident of West Point, this State, which they attacked, and deposited eggs that developed into larvæ that killed the tree.

Lyda sp. on Plum.—The past summer, as in previous years, a species of sawfly of the genus Lyda has been exceedingly numerous upon the wild and some of the cultivated plum trees growing in parts of the central region in this State. The larvæ or slugs feed in colonies, spinning webs and drawing the leaves of the branches and twigs together in a somewhat similar manner to that of the choke-cherry Tortrix (*Tortrix rileyana*). Although this insect has been exceedingly common and destructive to this tree for several years I have thus far failed to obtain specimens for the purpose of rearing the imago. Such few specimens as have been sent in have always arrived in a condition that prevented their development, and circumstances have always prevented me from visiting at the proper time the regions overrun to secure them for myself, nor have any of my correspondents from whom accounts of the insect were received sent me material that could be used for breeding purposes.

That this is a dangerous plum pest there can be no doubt, for entire groves are reported to have been stripped by the slugs within a very few days. Its unsightly webs and the curled dead leaves frequently remain upon the trees months after the injury has been committed. Several trials with London purple sprays have been reported as only partially successful.

The Cucumber Plant-louse.—The cucumber plant-louse (*Aphis cucumeris*) has recently made its appearance in the State in hurtful numbers. During the past summer complaints of its abundance were made by the Gedney Pickle Company, of Omaha, which has about 1,000 acres of cucumber vines planted each year. A visit on the 27th of July to the fields near the city of Omaha showed the louse present in moderate numbers in a few of the fields, but as Mr. Gedney remarked, "in a few days the entire field could be overrun by the pest." He, Mr. Gedney, has paid some attention to the study of this insect, and was very anxious about the outcome of the attack. Last year he said the com-

pany lost more than one-half of their entire crop of cucumbers on account of its attacks, and to be threatened again the present year was quite a check to the industry. This was especially hard since the custom followed by the company is to contract with the different farmers of the surrounding vicinity to plant a certain number of acres of the plants and agreeing in turn to pay for the crop at a given rate per bushel. The injuries wrought last year by the Aphis made it very difficult to induce others to plant for them the present year. The kerosene emulsion was suggested as a remedy that could be effectively used. Whether or not it became necessary to wage war upon the insect later I have not learned. The pickle industry has become of sufficient importance in the State to warrant our giving attention to the study of the insect enemies of the cucumber in future, and I shall try to make a special study of them another year.

Pine Scale-insects.—Reports of injury to pines by *Chermes pinicorticis* have reached me from time to time during the past two years. Thus far, however, no specimens of the insect have been received. Several times correspondents have sent twigs of pine containing the scales of the pine-leaf scale-louse (*Mytilaspis pinifoliæ.*) I have also observed this last-named insect in great numbers at several widely separated points within the State. It was seen upon a couple of trees growing on the lawn of Mr. J. H. Masters, near Nebraska City. In Omaha it was found upon some trees; at Tekamah it has been very abundant, and among the native pines of the northwestern part of the State it is the most characteristic insect enemy of these trees. Wherever this and other scale-insects abound they are attacked by several of our Coccinelid beetles, but more especially by the one known as the twice-stabbed ladybird (*Chilocorus bivulnerus*). Sometimes this ladybird is so numerous as to be present by the hundreds upon a single branch of trees infested with scale-insects.

Chinch-bug Infection.—In compliance with your request I present herewith a short statement relative to my experience with the chinch-bug infection for field use during the past summer here in Nebraska.

Early in the season (April) indications pointed to the probability of considerable injury during the year by the chinch-bug. Consequently it was decided by the board of regents at one of their meetings to carry on some experiments in the line followed with apparent success by Prof. F. H. Snow of the University of Kansas during the four or five years past. Certain funds were set aside with which to equip and carry on a laboratory for the propagation and spread of the fungus, *Sporotrichum globuliferum*, that is parasitic upon certain insects. Infected bugs with which to start were obtained from Prof. Snow. Live, healthy bugs were then gathered from whatever source they could be obtained, and these were placed in jars, boxes, etc., with the "starters," and the conditions made to conform as nearly as possible with the directions issued by the Kansas University and sent with shipments of the infected bugs. As

a rule no trouble was experienced in securing the spread of the disease from the infected to healthy bugs in the laboratory. Only twice during the earlier portion of our experiments did the infection seem temporarily to lose its virulence on account of lack of material. For a considerable time after starting in it was almost impossible to obtain the necessary live bugs from farmers living in infested portions of the State. As long as this was the case but few lots of dead or infected bugs were sent out from the station. Later, when bugs were received by us every day we found no difficulty in securing fungus-covered bugs in sufficient quantities to supply all applicants with the disease to be used in field experiments. Accompanying each small shipment of diseased bugs were sent directions for their use, these instructions being practically the same as those sent out by the Kansas station.

Later, about the third week in September, a circular letter asking for information was sent to each person who had received bugs from us. This was for the purpose of obtaining facts relative to the success or nonsuccess attending the experiments in the fields over the infested area by the farmers who had undertaken this portion of the work. Up to the present writing about one hundred replies have been received. Of these about one-half are favorable, the other half, uncertain or negative.

During the trials in the fields the weather was very unfavorable to the growth of Sporotrichum, being very dry and hot; hence the surprise that so large a proportion of the replies should be favorable.

Some of the correspondents reported the gathering of bugs in clusters where they died without presenting any indications of the fungus growth. These evidently died from the bacterial disease mentioned by Prof. Snow. It also was present occasionally in our breeding cages in the laboratory, where it did very effective work. It was especially noticeable during the warmer and dryer part of the summer.

REPORT ON SOME OF THE INJURIOUS INSECTS OF CALIFORNIA.

By D. W. COQUILLETT, *Special Agent.*

LETTER OF SUBMITTAL.

WASHINGTON, D. C., *November 7, 1893.*

SIR: I herewith submit my annual report for the year 1893. This consists principally of accounts of several kinds of leaf-eating caterpillars which attack various kinds of fruit and nut trees in California.

Very respectfully, yours,

D. W. COQUILLETT.

DR. C. V. RILEY,
U. S. Entomologist.

The Walnut Span-worm (Boarmia plumogeraria Hulst).—In Bulletin No. 30 (pp. 26–29) of this Division, I gave an account of a span-worm that had occasioned very serious damage to English-walnut trees in a certain locality in southern California. At the time of submitting that report none of the moths had issued from the chrysalis state, and I was therefore unable to give the technical name of the insect. Moths began to emerge January 5, 1893, and continued at intervals to March 25.

Owing to the fact that the female is wingless, and that the chrysalis state is passed in a cell in the earth, we are enabled to prevent the ravages of this pest by simply preventing the female moths from ascending the trees and depositing their eggs. To accomplish this many devices and substances have been used, as in the case of the canker-worms, the females of which are wingless, and the transformations of which are similar to those of the present species; hence every remedy that can be successfully used against the canker-worms is equally applicable to the present species.

Perhaps the simplest device to use for the purpose of preventing the female moths from ascending the tree consists of a band of tarred building paper about 6 inches wide, wrapped around the tree close to the ground and fastened with a stout string passed around the band near its upper edge. The lower edge of the band should be pressed firmly into the earth, so that no portion of the tree below the band is exposed to view. Some kind of sticky substance should be painted or smeared around the upper portion of this band to a distance of two or

more inches in width. For this purpose may be mentioned tar, printer's ink, molasses, melted India rubber, and a mixture of oil and resin boiled together. These bands should be placed upon the trees a short time before the first moth issues from the ground, and should remain upon the trees until the last moth of the season is dead. My notes indicate that in southern California this period extends from about January 1 to the latter part of April, and during this period the sticky substance should be renewed at short intervals, never allowing it to become sufficiently hard to permit of the moths passing over it. After the last moth of the season has passed away the bands should be removed from the trees, and thoroughly scalded, in order to destroy any eggs that may have been deposited upon them.

For a description of the numerous devices that have been employed for the purpose of preventing the female canker-worms from ascending the trees and depositing their eggs, the reader is referred to the Third Report of the United States Entomological Commission (pp. 183–188).

Prochœrodes nubilata Pack.—This is a second kind of span-worm that sometimes occurs in destructive numbers on the cultivated English walnut in southern California. It does not confine its attacks to this tree, however, as I have frequently found it upon apple and willow; but it appears to prefer the English walnut to any other tree. This span-worm is considerably flattened, and during the day time remains at rest in a crevice or other irregularity in the bark of the tree, and being of nearly the same color as the bark its presence is not easy to detect. In this respect it closely resembles the caterpillars of the red underwinged moths (*Catocala*), but is readily distinguishable by possessing only two, instead of eight, abdominal prolegs.

This span-worm has the same general appearance of the walnut span-worm referred to above, except that the tubercles or piliferous spots on various parts of the body are of nearly a uniform size, whereas in the latter some of those on segments 4, 5, 6, and 11 are much larger than the others.

When jarred from their perch these span-worms, in common with the other members of this group, spin a silken thread, by means of which they remain suspended in the air. I have never observed them assume a rigid attitude, attached to some object by the four posterior prolegs alone, a habit so common in related forms. Instead they rest with the body closely appressed to the bark of the tree.

The eggs from which these span-worms hatch are deposited singly, being attached at one of their sides. The young span-worm, in issuing from the egg, makes its escape through a circular opening in the flattened end. The full-grown span-worm secretes itself in crevices on the tree, usually beneath a loose piece of projecting bark; here it spins a thin cocoon, and shortly afterwards assumes the chrysalis form.

My notes indicate that at least three broods of these insects are produced in one year; the winter is passed in the larva state, and the

moths from these issue during the month of April. A second brood issues in August, while the third and last brood of the season makes its appearance in November and during the first half of December.

Both sexes are winged and it would therefore be quite useless to place obstructions around the trunks of the trees, as is sometimes practiced in dealing with those kinds of span-worms which are wingless in the female sex; moreover, as already stated above, the larvæ of the present species assume the chrysalis form on the tree instead of entering the earth, and this habit of itself renders the above-mentioned method entirely useless in dealing with this species.

Whenever these span-worms appear in destructive numbers, about the only practical remedy we are able to suggest is to spray the infested trees with Paris-green solution, composed of one pound of Paris green thoroughly stirred into 200 gallons of water. If a small quantity of soap is added to the solution this will cause it to spread more evenly over the tree. It should be borne in mind that a very small quantity of this poison will prove fatal to the recently-hatched span-worms, whereas the nearly full-grown ones will be able to withstand a much larger quantity of the poison. Hence the importance of applying the poison while the span-worms are still very young.

The Orange Leaf-roller (*Tortrix citrana* Fern).—This is a small, greenish caterpillar that ordinarily lives in a rolled or folded leaf, upon which it feeds, but it also has a habit of burrowing into the green oranges, causing them to turn prematurely yellow and finally to drop from the tree. I first obtained specimens of this insect on the 6th of May, 1885, and since that time have occasionally met with it, although never in large numbers. Last season, however, it appears to have been quite plentiful, judging from the number of letters received asking for information concerning it.

Although ordinarily met with upon orange trees, I have also found this leaf-roller upon apricot, willow, oak (*Quercus agrifolia*), wild walnut (*Juglans californica*), and golden-rod (*Solidago californica*).

The larvæ which live in the oranges desert their burrows and creep into some sheltered place when about to pass through their transformations, but those which live in rolled or folded leaves assume the chrysalis form within such leaves.

The time passed in the chrysalis state varies greatly according to the season of the year; my notes show that five of the chrysalides remained in this state 9, 11, 11, 12, and 19 days, respectively. There are doubtless four or five generations each year. I have found this insect in some stage of its growth during the months of January, March, April, May, June, and September, but it is most abundant in early summer. The species was described by Prof. C. H. Fernald, in *Entomologica Americana* (vol. v, p. 18), from specimens bred by the writer.

Two different kinds of internal parasites are known to me to attack this insect. The first of these is a small, black, four-winged fly belonging to the Microgastrinæ. The larva of this parasite when full-grown

issues from the caterpillar of the Tortrix and spins a compact, white, elongate-ellipsoidal cocoon measuring nearly 6 millimeters in length. When about to issue, the parasitic fly cuts a circular lid out of one end of its cocoon, from which to make its escape.

The second kind of parasite, of which I bred only a single specimen, is a small, grayish-black, two-winged fly belonging to the family Tachinidæ and apparently to the genus Phorocera, but the species is probably as yet undescribed.

Should the orange leaf-rollers ever appear in destructive numbers, I know of no more effective remedy to use for their destruction than that of spraying the trees with Paris green and water at the rate of 1 pound of the Paris green to 200 gallons of water. I have used this preparation on orange trees without in the least injuring the trees upon which it was sprayed.

It is quite impossible to ascertain to what country this species is native, though I strongly suspect that it was imported into California from some of the Pacific Islands. It is interesting in this connection to note that in his Narrative of an Exploring Expedition (vol. III, p. 13) Capt. Charles Wilkes states that the oranges grown upon one of the Friendly Islands "do not succeed because they are injured by an insect which leaves its larva on the fruit, and causes it to fall before it reaches maturity." While this description tallies fairly well with the present species, there is also a possibility that this reference is to a dipterous larva belong to the family Trypetidæ, two species of which are known to attack oranges in this manner.

The Brassy Cutworm (*Tæniocampa rufula* Grote).—On the 6th of June, 1888, I received a package of green apples, pears, and peaches from Mr. C. R. Johnson, of Pomona, Cal. The apples and pears had large cavities eaten into them, extending sometimes to the core, and nearly buried in one of the peaches was a naked caterpillar having the general appearance of an ordinary cutworm. The apples and pears were from three-quarters of an inch to an inch in diameter, and the peaches were somewhat larger.

Accompanying this package was the following letter:

I mail samples of the worm referred to in the Pomona *Times*, of which you make inquiry in your letter received today; also some fruit samples upon which they worked; viz, apple, pear, peach, and apricot. I found it difficult to get any of the worms; since the sun has been shining and the weather warmer they have almost entirely disappeared. I have not been able to learn of any very serious damage to the fruit in our immediate neighborhood. I think they would have destroyed the small amount that I have, but I went around each tree, and inside of a circle of about 12 inches in diameter, just at the roots, I dug out from 15 to 40 worms to each tree.

The Rev. J. F. Moody, of this place, tells me today that in his neighborhood he noticed that quite a large hole had been dug around each tree by the chickens, which I think destroyed the worms. A lady in the southern part of this city says that one of her neighbors has found some prunes with the inside eaten out by a worm of the same description as the one I send you.

During the cool, cloudy weather they could be found up in the trees throughout the day, and they destroyed flowers and small shrubbery.

This caterpillar has a polished appearance, and in certain lights shows a slight brassy reflection. When first exhumed from beneath dead leaves or other litter, it feigns death, but soon makes its escape by crawling beneath some object, its movements being quite rapid. It pupates within a small cell in the earth.

There are two well-marked broods of these caterpillars each year. The first brood pupates in January and February and the moths issue about six weeks later. The caterpillars of the second brood assume the chrysalis state in the months of June and July and are changed to moths from the first week in September to the middle of October.

It is very probable that the food of the caterpillars of this moth ordinarily consists of the leaves of various kinds of weeds, and that their fondness for green fruit has only recently been acquired. I have repeatedly found them beneath stones, dead weeds, and other litter lying upon the ground, and on the 9th of June, 1888, I found forty five of these caterpillars beneath dead weeds lying upon the ground under some orange trees in the city of Los Angeles.

Up to the present time this species has been reported only from California.

Associated with these caterpillars were the following predaceous beetles, which doubtless prey upon them: *Calosoma peregrinator*, *Calathus ruficollis*, *Platynus maculicollis*, *Pterostichus vicinus*, *Amara californica*, and *Amara stupida*. With two exceptions all of these beetles when exhumed endeavored to hide themselves again, but the *Calosoma* and *Amara stupida* would nearly always start up the trunk of the nearest tree. In the month of May of the present year I saw an allied species, *Calosoma latipenne*, engaged in feeding upon a caterpillar of *Agrotis saucia*. Indeed, this habit is so prevalent among the different species of Calosoma that they are called "caterpillar hunters."

The caterpillars above described are but little subject to the attacks of internal parasites. I have bred but a single specimen from a large series of caterpillars placed in my breeding cages from time to time. The parasite referred to is a large Tachina fly, which issued on the 29th of July, 1888. It apparently belongs to the genus Eucnephalia.

As to a remedy, the one practiced by Mr. Johnson, of exhuming the caterpillars and then destroying them, is perhaps the most effectual that could be adopted. If it should be proved that these caterpillars will feed readily upon green alfalfa or upon weeds of any kind, quantities of these could be gathered and pressed into balls, which could then be soaked in a strong solution of Paris green and water and placed upon the ground beneath the trees; the caterpillars by feeding upon these poisoned balls would thus be destroyed. Trees might be protected from the attacks of these insects by placing around the trunk of each tree a collar of smooth tin or other obstruction over which the caterpillars could not make their way. The custom of allowing chickens the run of the orchard before the fruit ripens will also result in

great benefit, since these useful fowls will succeed in digging up and destroying large numbers of these and other noxious insects.

While on the subject of caterpillars injuring green fruits, I may add that the well-known corn ear-worm (*Heliothis armiger*) sometimes eats out the interior of green peaches. On the 14th of June of the present year, Mr. G. A. Compere, of Los Angeles, handed me a green peach containing a caterpillar of this kind that had hollowed out the entire interior of the peach. I removed it from its habitation and offered it a fresh, half-grown peach, into which it at once began to gnaw an entrance. This caterpillar pupated during the latter part of June, and the moth issued on the 25th of July.

As also bearing upon this subject I may add that on the 13th of September, 1891, I received from Mr. F. G. Ryan a green orange about three-quarters of an inch in diameter, in which were two holes extending quite to the center of the orange, and in one of them was a half grown corn ear-worm, busily engaged in feeding upon the interior portion of the orange. This is the first instance that has come to my notice of this insect attacking oranges, although I have occasionally seen it feeding upon orange leaves.

Tent Caterpillars.—During the latter part of April, 1892, while investigating the leaf-eating caterpillars occurring in the orchards of Alameda and Santa Clara counties, I found quite a large number of colonies of a thinly hairy caterpillar which, by rearing to the perfect state, was identified by Dr. Riley as *Clisiocampa thoracica* Stretch.

The moths appear during the month of June, and shortly afterward deposit their eggs upon the smaller twigs of the trees on the leaves of which the caterpillars are to feed. The eggs are deposited upon one end in an irregular band completely encircling the twig and measuring from 5 to 9^{mm}. in width, each cluster containing upward of 250 eggs. These are arranged somewhat spirally, and are partially covered over with a brown substance resembling glue; but this does not entirely conceal the eggs. They do not hatch until the following April.

Shortly after issuing from the egg the young caterpillars proceed to spin over them a silken web or tent, and in this tent they pass the greater portion of their time when not engaged in feeding. Before attaining their full size they desert their tent and live exposed upon the tree, but still keep together in companies, and during the warmer portion of the day may frequently be seen huddled together upon one side of the trunk of the tree. I have found colonies of these caterpillars on cherry, plum, prune, and willow, and they fed indiscriminately upon the leaves of each of these trees. The caterpillars from the different trees were indistinguishable, as were also the moths into which they were finally transformed. On one occasion I saw a nearly full-grown caterpillar of this species feeding upon the leaf of the common nettle (*Urtica holosericea*). This was growing beneath a willow tree, and the caterpillar had evidently fed upon the leaves of the latter until dislodged by accident.

When full grown, these caterpillars crawl into some sheltered place and spin their thin, pure white cocoons. The cocoon proper measures from 18 to 26mm. in length, and the width is about two-fifths of the length. It is thinly sprinkled with a yellow powder, and around it is spun quite a large quantity of fine, soft, white silk. About four weeks elapse between the spinning of the cocoons and the issuing of the moths, the latter issuing at various hours of the day, from 9 o'clock in the morning to 5 o'clock in the afternoon. The sexes appear to be quite evenly divided; out of a total of 27 moths which I reared, 15 were males and 12 females.

I did not succeed in breeding internal parasites of any kind from these caterpillars, but they evidently do not altogether escape the attacks of such parasites, since I found two of the caterpillars each of which had a white egg of some kind of Tachina fly attached to its head. This parasite, however, appears to be very rare. Out of a total of 350 of these caterpillars which I examined the two mentioned above were the only ones showing any indication of its attacks; and from about 300 reared not a single parasite made its appearance.

As stated above, the young caterpillars spin a silken web or tent in which to dwell, and as this is a very conspicuous object, their presence upon the trees may be easily detected and the web with its entire contents may then be removed from the tree and burned, or destroyed in some other manner. Later in the season, when the nearly full-grown caterpillars are congregated upon the trunk of the tree they may be destroyed by wrapping a barley sack tightly around the trunk of the tree where they are located, thus crushing them. The method first mentioned is greatly to be preferred, since the white webs of the young caterpillars are much easier to discover than are the caterpillars themselves, and of course it is far better to destroy them at this time than to wait until they have committed all the injury to the trees that they are capable of doing.

In a certain locality in Alameda County I found a second species of tent-caterpillar upon cultivated gooseberries, and in a neighboring canyon this same species occurred in large numbers upon wild blackberry (*Rubus vitifolius*) and also upon willow. It is readily distinguished from the one described above by the velvet-black color of its body which is marked with a series of indistinct dull orange yellow dashes that sometimes form two more or less distinct dorsal lines and a lateral line; on either side of each of the segments from the second to the eleventh is a transverse, bluish-gray subdorsal spot; the spiracles and venter are wholly black; the body is thinly clothed with reddish hairs which are most abundant on the back and low down on each side of the body; the head is opaque black, the clypeus gray and bordered below with yellow. The full-grown caterpillar measures about 35mm in length. The cocoon resembles that of the preceding species but is somewhat darker and more dense, the yellow powder is more abundant,

and the loose, fine, soft silk spun about the cocoon is less in quantity. The cocoons are spun in May, and the moths issue in the latter part of that month and during the month of June. The two sexes are so dissimilar in color that they might readily be supposed to belong to two distinct species. The males are of a reddish brown ground color, while in the females the color is a light, ocher yellow. The moths issue at almost every hour of the day and night, and the sexes are evenly distributed. This species is *Clisiocampa californica* Pack.

I found but a single cluster of eggs of this species, but these had already hatched and near them was the silken tent and colony of young caterpillars that had issued from these eggs. This cluster was attached to a small twig of a willow tree; it measures 16^{mm} in length and reaches only two-thirds of the distance around the twig. The eggs number about 150 and are arranged in irregular oblique rows; they are thinly covered with a substance somewhat resembling glue, which on one-half of the cluster completely conceals the eggs from view.

As in the preceding species, the young caterpillars spin a silken web or tent in which to live, but after becoming about half grown they desert this and lead a wandering life; they do not appear to possess the habit of congregating together when not feeding, which is such a characteristic trait of the preceding species. Besides the food-plants mentioned above, Mr. Henry Edwards states that these caterpillars also feed upon the leaves of the apple, pear, oak (*Quercus agrifolia*), ash (*Fraxinus oregona*), buckeye (*Æsculus californica*), California holly (*Heteromeles arbutifolia*), and Madroñe (*Arbutus menziesii*). (See Fifth Report U. S. Entomological Commission, p. 119).

Three different kinds of internal parasites are known to me to attack these caterpillars. On the 17th of May, 1892, a larva of a Tachina fly issued from one of them and soon afterward pupated. On the 9th of May a larva of an Ichneumon fly spun its cocoon within the body of a one-third grown caterpillar in which it had lived, causing the body of the caterpillar to swell out and burst open on the underside, the cocoon as spun protruding through this opening and fastening the body of the caterpillar to the surface upon which it rested; the winged parasite issued ten days later, and has been identified by Dr. Riley as *Limneria fugitiva* Say. This parasite has not previously been reported as occurring west of Missouri, where Dr. Riley bred it from the larvæ of four different kinds of moths, including the forest tent-caterpillar (*Clisiocampa disstria* Hübn.). (See *Insect Life*, vol. III, p. 157).

The third parasite referred to issued on the 28th of May. It belongs to the family Braconidæ and to the genus Rhogas.

The above two were the only species of Clisiocampa that I found in the orchards of Alameda and Santa Clara counties. Neither of these occurs in southern California, so far as I am aware, but a third species, *Clisiocampa constricta* Stretch, is not rare in certain parts of Los Angeles County, where the caterpillars feed upon the leaves of an ever-

green oak, *Quercus agrifolia*. These caterpillars are not common in the valleys, but along the mountain sides they are sometimes very abundant, and I have found them at an elevation of nearly 5,000 feet. So far as at present known, they attack only the various kinds of oak.

So far as I have observed, these caterpillars do not spin a web or tent in which to live at any period of their lives. The cocoon is of a pure white color, and the powder with which its meshes are partially filled is also white, and not yellow, as in the two preceding species. The loose silk spun about the cocoon is scant, and is much coarser and stiffer than that of the preceding species. The cocoons are spun in May and June, and the moths issue in June and July. Two male and four female moths which I bred all issued from the chrysalis after 5 o'clock in the afternoon.

Three different kinds of internal parasites are known to me to attack the caterpillars of this Clisiocampa. On the 5th of July, 1891, two Tachina flies issued from some of these caterpillars in one of my breeding cages; these flies are known as *Masicera frenchii* Will., hitherto reported only from Maine, where it attacks the larvæ, or chrysalides, of a large butterfly, *Papilio turnus* var. *glaucus*. Under a high power the eyes of this parasite are seen to have a few microscopic hairs. Heretofore it has not been reported west of Colorado. I have bred a closely related species, *Masicera archippivora* Riley, from the chrysalides of two kinds of butterflies, *Pyrameis cardui* and *P. caryæ*.

A single specimen of a second kind of Tachina fly was bred in July, 1892, from a caterpillar of the above Clisiocampa by Dr. A. Davidson, of Los Angeles, to whom I am indebted for this specimen. It issued from the caterpillar after the latter had spun its cocoon, but before the change to the chrysalis had taken place.

The third kind of internal parasite which attacks the caterpillar of this Clisiocampa belongs to the family Ichneumonidæ, and has been identified as *Pimpla inquisitor* Say. In the month of June, 1887, six larvæ of this parasite issued from one of these caterpillars after the latter had spun its cocoon, and spun their white cocoons within that of their host; the winged parasites issued during the following autumn. This parasite is very widely distributed, being found as far eastward as Washington, D. C. It infests a great variety of caterpillars and has also been bred from larvæ found feeding upon the eggs of spiders. On the 26th of April, 1892, Dr. Davidson bred five specimens of this Pimpla from some egg-masses of the spider, *Epeira angulata* Clerck.

ARSENIURETED AND SULPHURETED HYDROGEN AS INSECTICIDES.

Not being entirely satisfied with my experiments with these two gases in the past, and wishing to test arseniureted hydrogen produced in a different manner than previously employed by me, with a view of discovering a cheaper gas than hydrocyanic acid to be used for the destruction of scale-insects on citrus trees, etc., I decided to

make a series of experiments with these two gases. Accordingly, during the months of March and April of 1893, I carried out such a series of experiments, the results of which but confirm my previous statements to the effect that both in regard to the expense and effectiveness hydrocyanic-acid gas is preferable to either of the two gases mentioned above.

For the production of sulphureted hydrogen I used iron sulphide (FeS), commercial sulphuric acid (H_2SO_4), and water. The iron sulphide was obtained for 20 cents per pound, and requires about the same quantity of sulphuric acid and water that potassium cyanide requires in the production of hydrocyanic-acid gas. The sulphide was partially pulverized, and none of the pieces were over one-eighth of an inch in diameter. When the acid was added to the sulphide, no action took place, but as soon as the water was added, quite brisk action at once began, with evolution of the ill-smelling gas. The action of the acid and water upon the sulphide was very much slower than their action upon potassium cyanide, even when the latter is used in large pieces. The tests were made during the month of March, from about 9:30 o'clock in the forenoon to about noon of different days, when the weather was comparatively cool.

When used so strong that its cost about equaled that of potassium cyanide used for the purpose of generating hydrocyanic-acid gas, the resulting sulphureted hydrogen was fatal to a very small percentage of the insects (*Lecanium hesperidum* and *L. oleæ*) on the orange trees experimented upon, and the leaves upon these trees were not injured by the gas. Here I used about three times as large a quantity of the sulphide as would have been required of the cyanide to destroy all the insects of the tree, but it was scarcely one-tenth as effectual as the latter, and I therefore considered it would be quite useless to continue experimenting further with the iron sulphide.

I had in previous years generated arseniureted hydrogen by acting upon small pieces of sheet zinc with commercial sulphuric acid in the presence of an aqueous solution of white arsenic (AS_2O_3), but as this is a somewhat imperfect method I decided to test the method of generating this gas by acting with water and sulphuric acid upon zinc arsenide (AS_2Zn_3). Failing to obtain the last-mentioned substance at any point on the Pacific coast, I was under the necessity of having it manufactured expressly for my use. Accordingly I made the necessary arrangements with Wade & Wade, manufacturing chemists of Los Angeles, Cal. The arsenide is manufactured from metallic zinc and arsenic, one and three-tenths parts of the former being used to one of the latter. The price of metallic arsenic in San Francisco, is 50 cents per pound, and of granulated zinc, 60 cents. The two metals in the proportion above given were placed in a crucible along with a small quantity of powdered charcoal, and the crucible closed and subjected to the heat of an assayer's furnace for a space of about twenty

minutes, after which it was removed from the furnace and allowed to cool. The resulting arsenide was very brittle, and pulverized readily.

Even when the arsenide was used in such large quantities that its cost was three times as great as that of potassium cyanide used in sufficient quantity to destroy all the insects on the tree, it proved fatal to only about two-thirds of the scale-insects (*Lecanium hesperidum* and *L. oleæ*) on the lower portion of the tree, while those on the upper portion escaped unharmed; the tree operated upon was less than five feet in height, and was not appreciably affected by the gas. The latter was confined upon the tree for a space of a full hour, and yet, owing to the great specific gravity of the gas, it did not become thoroughly diffused throughout the space inclosed by the tent. Owing to this characteristic of arseniureted hydrogen, and the further fact of its being more expensive than hydrocyanic-acid gas, there is nothing to recommend it over the last-named gas.

These experiments indicate that for the destruction of insects on trees hydrocyanic-acid gas is much cheaper than either arseniureted hydrogen or sulphureted hydrogen.

REPORT ON ENTOMOLOGICAL WORK IN OREGON AND CALIFORNIA; NOTES ON AUSTRALIAN IMPORTATIONS.

By ALBERT KOEBELE, *Special Agent.*

LETTER OF SUBMITTAL.

ALAMEDA, CAL., *November 8, 1893.*

SIR: I herewith submit to you my report of observations during the year. Special reports on work done in Oregon and Washington upon *Phorodon humuli* Schrank., and on the investigation of the condition of predaceous insects sent from Australia during my last trip to that country, have been made and forwarded to you. I shall here mention only certain additional facts connected with the same and note some other observations made.

Respectfully, yours,

ALBERT KOEBELE.

C. V. RILEY,
U. S. Entomologist.

The hop louse, as could plainly be noticed during spring, has not been so numerous during the present season in Oregon and Washington, owing to the increase of insects living upon it, as shown by the interesting letter of September 16, 1893, from Mr. H. J. Miller, of Aurora, Oregon, as follows:

* * * The hop crop is very light, owing to cold rains in the spring and then continual dry weather. In the spring when the lice emigrated to the hop the weather was cold and rainy, and I noticed that the lice on the vines would turn white and sickly and finally die. No spraying was done, as it was not necessary in this vicinity. A few lice survived the cold weather, and just before picking time the weather turned sultry, cloudy, and rainy, favorable for development of lice, and it could be noticed that they increased very fast; but picking time was too close at hand for them to do any damage.

As to collecting the lice from the plum trees, I have great faith in it, but to make it successful, farmers for miles around should closely inspect their trees and free them from vermin. One hop yard seemed to be infested as much as any of those of our neighbors, but as some of our nearest neighbors had plum trees and did not clean them, I am sure some of the lice emigrated from their trees to our yard, for they must be able to travel long distances. The ladybirds increased for a while in the spring, but as the summer advanced they began to dwindle away, and at picking time were getting scarce. * * *

A fungous disease appears to have destroyed large numbers during the early summer. It was only at picking time that the lice became numerous, and in consequence the coming season may again show an increase. As already mentioned, the importance of an early warfare against the hop louse can not be overestimated. Spraying and hand-picking should be practiced upon all the plum and prune trees during the autumn and early spring.

Since the season has been so backward it is not possible for me to give a list of the most efficient enemies of the hop louse, viz, the Syrphid flies, and but few of these were observed during my work. Coccinellidæ, however, could be seen by the thousands during early spring. I give a list of those met with in the yards, with notes thereon.

Notes on Ladybirds found in Hop Yards.—The largest number were of the genus Hippodamia, and it is a difficult matter even for an expert to define the species when seeing large numbers together. *Hippodamia convergens* Guer. and *H. ambigua* Lec. were the most numerous in the hop yards during the early spring and were preying upon various Aphidids infesting weeds. After devouring all these, they, as well as all other species, left in all directions and could be found almost anywhere where plant-lice existed. As observed, these insects will also prey upon Lecanium in its young stages after the most of the Aphidids have disappeared. *H. 13-punctata* has been but rarely met with. *H. spuria* Lec. and *H. parenthesis* Say were more numerous and always upon plant-lice. *Coccinella annectans* Crotch is a rare insect that feeds upon Aphidids as well as upon the young of Lecanium. *Coccinella trifasciata* Linn. is an abundant ladybird that is found feeding anywhere upon plant-lice, and as these become rare with the advance of the season, it readily feeds upon bark-lice. *C. transversoguttata* Fab. is one of the largest of this group and was also found in numbers in the hop yards as long as the plant-lice upon which it preys existed. The first eggs of any found amongst hop vines belonged to this species. This was before the yards were plowed, which will destroy nearly, if not all, the early stages of these valuable insects. *Cycloneda sanguinea* Linn. is a very common ladybird and one of the most active in hunting up the solitary Aphidids. Many colonies of the hop louse under observation on plum and prune trees were entirely cleaned out by this beetle and often in a single day. In order to get at the proper results of the experiments it often becomes necessary to cover the lice treated with netting on account of this insect. *Adalia bipunctata* Linn. is only occasionally found. I have bred the same from larvæ feeding upon an Aphidid infesting Cratægus at Sisson, Cal. It has also been found near Alameda, upon orange trees infested with Lecanium.

A. humeralis Say was found feeding upon plant-lice in Oregon and in California. I found it more often upon plants infested with black scale. A very common and variable ladybird is *Harmonia picta* Rand., which is met with occasionally feeding upon plant-lice. The

pine and fir trees in Oregon which are infested with Kermes are alive with this beetle, and the same may be said of the Monterey pine infested with Lecanium, upon which this insect preys. *H. 12-maculata* Gebl. has been but rarely found in Oregon feeding on plant-lice.

Our largest Coccinellidæ, Mysia and Anatis, are also aphis-feeding insects, yet they are but rarely met with since they live upon high coniferous trees infested with Lachnus. In warm days during early spring they were often found coming out from their winter quarters, out of old stumps, from behind bark of trees, etc. Amongst the coniferous trees, *Mysia hornii* Cr., *Anatis 15-punctata* Oliv., *A. rathroni* Lec. and *A. subvittata*, Muls., were met with.

Psyllobora 20-maculata Say is found nearly everywhere, yet I can say nothing in regard to its value as an aphis-feeder. It can be found in large numbers and in all stages feeding upon the powdery mildew (*Uncinula spiralis* B. & C.) upon our grape-vines and no doubt upon the mildew of other plants as well.

Our smallest Coccinellidæ, the Scymnids, are chiefly found to be Coccid-feeding insects, yet *Scymnus nebulosus* Lec. can be considered a valuable agent in destroying the hop louse. In one instance this beetle destroyed a colony that had been established upon a vine for about three weeks. *Scymnus* sp. near *tenebrosus* Muls. is occasionally found upon the hop louse, also in large numbers feeding upon Kermes on fir trees.

Some Oregon Fruit Insects.—One of the most abundant and injurious insects to fruit buds in Oregon is *Syneta albida* Lec. I noticed that a great part of the buds and blossoms on prune and plum trees were eaten out, and it was not long before this beetle could be observed doing the mischief. So numerous were they that along the edge of a fir forest, upon plum trees, from fifty to one hundred could be shaken off of every tree. Owing to its pale color, this beetle is not easily noticed among the blossoms where it hides itself, yet it can easily be shaken off.

A Tortricid larva that eats into and destroys a large part of the currant berries was observed in Oregon. The green as well as the ripe fruit is attacked by the larva that lives in a web among the berries.

Carpocapsa pomonella has become very numerous and destructive in that State, and as with nearly all newly introduced insects, its work will be very seriously felt for a few years to come, until some natural enemies will acquire the habit of feeding upon it. The enemies of this insect are already many. During the present season I have bred this moth from cherries.

In Australia I have bred many species of Oscinids from larvæ preying both upon Coccidæ and Aphididæ. After my return to Alameda a similar larva was found preying upon a small Aphidid that infests *Physianthus alba*. During the autumn of 1892 six of these larvæ were placed in a vial and from these three parasites were bred this spring.

During July of the present year these larvæ were again very numerous, as well as the mature flies upon the same plant, and many were bred from larvæ inclosed. While the larvæ of these flies prey upon all sorts of Aphidids in Australia and are frequently found upon those on orange and corn, this is the first time that I have observed them in California.

During July of 1891 many of the eggs of *Selandria cerasi* examined upon young pear trees were found to be infested with a parasite, while others showed holes from which parasites had issued.

Notes on an introduced Australian Ladybird.—Since reporting upon the recently introduced *Rhizobius ventralis* Gr. I have made further notes which may be of interest. A colony of these beetles received from Hon. Ellwood Cooper and liberated by Mr. S. F. Leib, of San José, upon *Lecanium oleæ* infesting prune trees July 23, 1893, were examined August 23 of that year, and numerous half-grown larvæ were found. On looking over the same trees September 22, only a few grown larvæ could be found, yet pupæ were numerous. At my own place a few of the mature insects were liberated upon *Physianthus alba* infested with *L. oleæ* August 21. Grown larvæ were here observed October 6, and on the 17th of the same month many pupæ were present. One of the females liberated upon this plant August 21 was still present and laying eggs. The same conditions were found at two other places in Alameda where this insect had been colonized upon black scales. As this Rhizobius will breed during the entire year, fully six broods can be expected in the southern part of the State. The mother beetle will deposit her eggs under the older Coccids in numbers. Often an entire scale is found completely filled with the eggs of the Rhizobius. After the young larvæ issue they remain under the scales and devour eggs and Coccids before leaving. The plants may be full of young larvæ, yet these are seldom seen, since they most always remain under the older scales and feed upon the contents. As they become larger they can occasionally be noticed walking around while feeding, yet are found more numerous hidden away between curled-up leaves and even among spider webs, where many pupate. If liberated upon any bush or tree infested with Lecanium, a gravid female will at once begin to oviposit, and will not leave the plant as long as there is sufficient food for the offspring.

While looking over a lemon tree infested with *Lecanium oleæ* and *L. hesperidum*, upon which this Rhizobius had been liberated August 21, I was agreeably surprised, not only in finding large numbers of the same in all stages, but also *R. debilis* Black. that had been liberated in my yard upon *Aspidiotus perniciosus* by Mr. Craw during May of 1892. The tree mentioned is about one-half mile distant from the original spot, where the same insect can still be found.

NOTES ON THE INSECTS OF MISSOURI FOR 1893.

By MARY E. MURTFELDT, *Temporary Field Agent.*

LETTER OF SUBMITTAL.

KIRKWOOD, MO., *November 22, 1893.*

SIR: I inlose herewith my account of the more conspicuous of the injurious insects observed in Missouri during the past season. As in previous years, my grateful acknowledgments are due to you for many determinations.

Very respectfully,

MARY E. MURTFELDT.

Dr. C. V. RILEY,
U. S. Entomologist.

Among the entomological developments of the earlier part of the current year may be noted the appearance of the army worm (*Leucania unipuncta*), in such numbers as to justify its appellation, in hay and grain fields contiguous to streams and lowlands, where it caused considerable loss. It also occurred in large numbers together with other cut-worms in vegetable gardens as well as on the lawns and meadows of St. Louis County, and was frequently brought or sent to me as a depredator upon vegetables. So far as it came under my personal observation, however, when found in gardens, it was merely feeding upon the grasses that had come up among the other plants. The moths were unusually abundant during September.

During the latter part of the season there was an unusual outbreak of our indigenous locusts (grasshoppers). The meadows, gardens, berry beds, nurseries, and young orchards were seriously ravaged by these pests. The species most abundant were *Schistocerca americana*, *Œdipoda sulphurea*, *Œ. xanthoptera*, *Melanoplus bivittatus*, and the omnipresent *M. femur-rubrum*. In some of the nurseries and newly set orchards of St. Louis County not a leaf was left entire on apple, pear, and plum trees, and the tender twigs were also in many instances completely barked, thus destroying the season's growth. Spraying with Paris green was resorted to by numbers of nurserymen, and, in a measure, protected the stock from premature defoliation. So far as I can learn the hopper-dozer is not extensively, if at all, used in Missouri, and, indeed, on the hilly and uneven surface of the greater part of the State it could not be employed to much advantage.

Among orchardists there was, in the spring, great complaint of the work of the buffalo tree-hopper (*Ceresa bubalus*). Bundles of scarred and blighted twigs were sent to me from many sections of the State, including the Olden fruit farms, in Howell County, the most extensive in the country, and the Flint Hill orchards, in Oregon County, both on the southern boundary of the State; from Kansas City on the west, and from Holt County in the extreme northwest, showing that the insect is by no means local. A considerable proportion of these twigs showed the cuts of several previous years, as well as the more characteristic recent punctures. From this it would seem that the insect remains in the neighborhood of its breeding place until the languishing branch or tree no longer affords it sustenance. Like all haustellate species it can be exterminated only by such insecticides as kill by contact, such as kerosene emulsion, thymo-cresol, and preparations of carbolic acid; and the use of these on the tender foliage, amid which the little spiny-backed hoppers lurk in the early summer, is apt to have a bad effect. From eggs placed the preceding autumn was bred in considerable numbers a minute egg parasite, which proved to be an undescribed species of Cosmocoma. This little fly had destroyed the larger proportion of the eggs sent to me, and may in time render its host innocuous. The tree-hopper is quite common in the vicinity of St. Louis, but no conspicuous injury from it has come under my observation.

A leaf-hopper, *Ormenis pruinosa*, was remarkably abundant in vineyards, where it was popularly mistaken for "mealy bug," and caused considerable blighting of leaves and twigs. An interesting parasite, which attacks the full grown larvæ and pupæ, inclosing them with itself in a convex disk composed of two mica-like plates joined at the edges, was bred from a number of the clusters and determined as an undescribed Dryinus. This parasite is unfortunately rather rare.

The Osage-orange Pyralid (*Loxostege maclurœ* Riley) is spreading over the State, its work being most disastrous on young hedges, the growth of which it seriously checks. Spraying with Paris green during the months of June and July has been practiced to some extent in the vicinity of St. Louis, and has been found a reliable remedy. But it is so difficult to secure concerted effort in this direction that the increase of the insect is not materially interrupted. Close clipping of hedges about the 1st of August is also advisable, as at this time a majority of the eggs and newly hatched larvæ of the second brood are on the leaves and are, by this process, removed and burned. In the course of a few minutes' examination of some clippings, I found many egg masses and clusters of young larvæ, and noted that during the remainder of the season the worms were far less numerous than they had been the previous year when the hedge had been trimmed earlier. Pruning about this time may therefore be relied upon as an important preventive measure.

It is perhaps worthy of record that the large, formidable appearing larvæ of both *Citheronia regalis* and *Eacles imperialis* were never before so abundant in this locality as they were this autumn. They were brought to me again and again as something very wonderful and from appearances very dangerous. About the 1st of August a battered female of *imperialis* was brought me in a box in which in the course of two or three days she placed two hundred and seventy-five eggs. These were subglobose, 4mm in diameter, of a cream white color, streaked or tinged with pale brown. The larvæ hatched in seven days. As I was about leaving home for several weeks the young larvæ were placed upon a small sycamore tree (Platanus) and left to their fate. Upon my return a careful examination resulted in the discovery of about a dozen of the half grown larvæ. These also disappeared one by one, having been, in all probability, devoured by birds.

The Horn Fly.—The past season was notable for the invasion of the State by this cattle pest, at least for its manifestation in such numbers as to prove injurious to cattle and excite alarm among stock-growers. The newspapers contained numerous references to it, many of them of a sensational character, although the reality was in most instances quite bad enough. The insect was reported to me by letter from six or seven different sections of the State and has undoubtedly appeared, in greater or less numbers, over the entire area. In our suburb of Kirkwood and on the neighboring dairy farms its attacks upon the delicate and thin-skinned Jerseys were very disastrous, certain cows showing much greater sensitiveness to its bites than others. The cause of the trouble was not immediately recognized, but as soon as the fly was identified the remedies suggested by the Department were applied and brought measurable relief. Our town veterinarian recommended for the cases to which he was called an application of liquid tar, to be procured in pint cans from druggists. This was thickly spread over the shoulders, neck, and udder, and, though very disfiguring, was, all things considered, the best repellant used, as its effect extended over a period of a week or ten days, much longer than that of kerosene emulsion or carbolized vaseline. It is, however, more expensive both in money and labor, and, therefore, not so well adapted to use on large herds of cattle as the kerosene emulsion. The habit of the horn fly of resting on the cattle by night as well as by day gives the latter no respite, since, even when not biting, its presence seems to be irritating. From my observations this year, however, I draw the hopeful conclusion that in our climate and that of Kansas and southern Illinois it will not be able to multiply as it does in localities not subject to annual and protracted droughts. After dry weather set in the droppings were so quickly hardened that the larvæ were unable to develop, and by the 1st of August but few flies were noticed upon cattle in this locality. We also found that chickens in the stable yard and pasture rendered good service by scratching into and spreading the droppings and pick-

ing out whatever larvæ were contained therein. I have not been able to learn that much was done in the State in the way of spreading or liming the manure but this will doubtless in time become one of the regular duties of our herdsmen ; while the use of the repellant sprays and other applications, when necessary, will serve to protect the animals, not only from the particular insect under consideration, but from the attacks of bot-flies, Tabanids, Stomoxys, and other biting flies from which they ordinarily suffer exceedingly.

The Fruit Bark-beetle.—Previous to the current year there is but one brief reference to the presence of the above-named insect, the *Scolytus rugulosus* of Ratzeburg, in Missouri. This is found on the last page of the third volume of the *American Entomologist*, published in 1880, where Prof. Riley mentions, after determining the insect for various localities in the Eastern States, that he "had received the insect some years ago from Hillsboro, Mo., attacking the peach." Probably it has occurred, unrecognized, in many orchards since that date, where its work was referred to that very comprehensive affection termed "blight." However, during the past spring several correspondents of the *Rural World* and the St. Louis *Republic* discovered the minute beetles emerging through the pin-hole-like orifices in the bark of twigs and small branches of peach, plum, and cherry, and specimens were sent to me for determination and for the purpose of finding a remedy. From Clayton, in St. Louis County, Mr. J. W. E. Bellville, one of the county officials, sent me specimens of the insect early in May, emerging from twigs of cherry, with the information that one or two of his trees had already been killed by them and that the beetles were so numerous that he feared the destruction of his entire orchard. An examination of the twigs revealed a large number of the beetles, and under the bark a few full-grown larvæ and pupæ. The beetles were engaged in boring back into the twigs, in every case, so far as noticed, entering through the latent buds and even through some that were unfolding. By August the trees severely affected had lost most of their leaves, the bark of the branches was shrunken, and the twigs were breaking off. Beetles were again found making their way back into such twigs and branches as showed a measure of vitality. Very few larvæ were found in the portions of the trees examined, and such as were discovered were ready to transform, indicating the double-broodedness of the insect. Mr. Bellville wrote me that he thought he had protected some of his trees by spraying at this time with Paris green. So far as I have been able to find out by personal examination and inquiry the insect is yet quite local in the State, and if horticulturists can be brought to realize the danger of neglect in this case it can no doubt be held in check, if not entirely stamped out.

The Pear-tree Clear-wing Borer in Apple.—This insect (*Ægeria pyri* Harr.) appears for the first time, I believe, to swell the ranks of the almost innumerable pests of the apple tree, upon which it may prove more injurious than it has hitherto done upon the pear.

Early in May I received from Mr. S. W. Gilbert, of the Flint Hill fruit farms, in Oregon County, a few small lepidopterous larvæ taken from the young apple trees, with the information that "the worms eat the inner bark next to the hard wood and are usually, if not always, concealed at least one-eighth of an inch from the dead bark." Mr. Gilbert further says: "I find the insects especially abundant on trees that have been 'sun scalded' on the southwest side. They work at the edges of the green bark next to the dead portion of the tree. Among the young Missouri pippin trees last year I found a large number that had on their trunks from one to several spots of dead wood about twice the size of a silver dollar, and in every case we find this spring these worms working around the deadened spot." The larvæ accompanying the above note were about one-half inch in length by one-tenth inch in diameter, subcylindrical, of a yellowish-white color, with a few scattered soft white hairs arising from inconspicuous piliferous plates. Head dark brown, rather broad and short, collar covering rather more than half of the top of the first joint. The appearance was almost precisely that of a Tortricid, except that the jaws seemed somewhat broader and stronger. In the course of a few days, however, the peculiar cocoons, or follicles characteristic of the Ægerians were formed between pieces of bark, except in the case of two larvæ, in whose place appeared two rather large white cocoons of a parasite, probably an Apanteles. But one of these developed and this, to my very great regret, escaped from the rearing jar and could not be recovered. On June 9 two moths emerged, both males, which upon comparison proved to be the species above named. These were the only examples that I was able to obtain, but several other correspondents reported borers in young apple trees whose habits seemed to agree with those sent by Mr. Gilbert.

In all cases it was recommended to drench the trunks of the trees with kerosene emulsion two or three times during the months of June and July, or to apply the soft soap and soda mixture that has been so often used to prevent the borer beetles from laying their eggs. As it was not asserted that this Ægerian confined its attacks to that portion of the trunk just above ground, as is the habit of the allied peach borer, I could not advise mounding as a preventive.

The Peach or Plum Bark-louse.—While at Carthage, in Jasper County, last December, in attendance at the annual meeting of our State Horticultural Society, one of the residents of the city brought me a number of peach twigs from his orchard in the suburbs, thickly covered with the characteristic scales of *Lecanium persicæ* Fab., with the information that many of his trees had become unthrifty and unfruitful in consequence. This was my first acquaintance with this scale, as it has not hitherto proved sufficiently injurious to attract much attention from peach-growers; and upon looking up such of its literature as was at my command I found that its complete life history had not been published.

Early in April other infested twigs were sent to me from Jefferson County, and, about the same time, a subscriber of the *Rural World* sent still others over which were scattered the largest and most brightly colored scales that had yet met my eye. They were not darkened by the smut fungus which after a year or two follows the attacks of this insect and completes the disfigurement and destruction of the tree. The scale is a very handsome one, as scales go. The form is hemispherical, tending to conical in the center, 2.5 to 4^{mm} in diameter; surface highly polished, though not smooth, being indented with more or less distinct, shallow, crenulated grooves, radiating from the center to the margin; general color black, or very dark brown, with a longitudinal dorsal band of bright, sealing-wax red and fine streaks of red alternating with broader ones of paler brown to form a border. When detached from the twig during winter or early in the spring, the under side will be found slightly concave and, occupying the center, is the still quite well-defined body of the female, surrounded by a brown jelly like substance which fills the remainder of the shell across which four, or sometimes six, diminishing white thread-like lines extending to the edge of the scale, have the appearance of legs and would seem to assist in keeping the scale in place. When lifted carefully from the posterior end, the long hair-like beak can be distinguished with a strong lens and is capable of being drawn out to a length of 2^{mm}.

On May 2, my attention was called by a friend to a young Lombard plum in his garden, which exhibited the worse case of attack yet seen—probably the unchecked development of several seasons. The twigs and smaller branches were absolutely incrusted on all sides with the Coccids, presenting to other than entomological eyes, a repulsive spectacle. Even at this late date segregation had not taken place. By the 20th of the month, however, the eggs were fully formed and every scale was crowded with them. The egg is broad oblong in form, 0.5^{mm} in length, pale yellow in color, and in the mass quite free and granular. Hatching began June 10 and continued for nearly a month. The young larvæ were the largest species yet observed, very flat, uniformly pale yellow, the carapace being indicated by a very thin lateral rim. The legs were rather long and well developed. Antennæ five or six jointed, one-half the length of the body. By July 15 hatching was completed, and in the meantime, those first hatched, of which a part were separated and kept on fresh twigs in the rearing jar, had nearly all become stationary on the leaves and transformed to male pupæ. Twigs brought me from the tree at this date had the foliage covered with the young in all stages, the majority being still in a state of great activity, resembling in general appearance and in the peculiar wavy motion when crawling, a myriad of small Tingitids. The sexes were undistinguishable. The mature larval scale is about 2^{mm} in length, slightly convex, of a translucent greenish-white color. Two converging carinæ inclose a narrow flat dorsal space, from which a border,

divided into six or seven panes, by similar, though finer, opaque, white ridges, slopes slightly on all sides. Under the scales, which were stationary, and which in no respect differed from those that were still moving about over leaves and twigs, were found male pupæ entirely detached and displaying wing pads and other members as seen in nymphæ of the higher Hemiptera.

On the 22d of July winged males appeared in the rearing jar, the pupal period being about one week. In this stage, also, the insect is beautiful, with filmy, iridescent wings expanding 4^{mm}; body rose red, with some dark brown shadings about the head and tip of the abdomen, and an especially distinct, dark-brown, transverse thoracic band. August 10 hundreds of winged males, fresh pupæ, and active larvæ were still found on the leaves. The act of copulation did not come under my eye, although the winged forms continually fluttered over those that were crawling. The life of the male seems to be of about a week's duration. My observations on this insect were interrupted by absence from home from the middle of the month until the 5th of September, when I found that the males had disappeared and that the females had attached themselves to the bark of such twigs as still retained a measure of vigor. The scales were about one-half grown, had darkened, thickened, and become centrally elevated. As in all scales, growth by the exudation of waxy material around the margin was slowly progressing. At the present date (November 10) the scales are not more than two-thirds the size that they were last year and not nearly so numerous and drop easily from the twigs upon which the black fungus has appeared. This is very likely due to the debility of the tree, which will scarcely survive the winter.

Among the natural checks of *Lecanium persicæ*, one true parasite (*Chiloneurus albicornis*) was bred in small numbers from the mature scales and the active young were extensively preyed upon by Chrysopa larvæ, by *Camptobrochis nebulosus*—a small, speckled, gray bug that I have always found in numbers upon leaves infested with *Phylloxera rileyi*, the oak Chermes, and similar minute forms—and more especially by the flocculent larvæ of a small Coccinellid about 3^{mm} long and nearly as broad, black, with a red spot on each wing cover, which has been kindly determined for me as *Hyperaspis signata*. The larvæ of the latter were very numerous and active among the swarming young of the Lecanium, but, strange to say, were not found on any other Coccid or Aphis during the season. As I was desirous of preserving this Lecanium through the summer for study, no insecticides were used upon the tree, but from experiments made upon several twigs and branches there is no doubt that kerosene emulsion, thymo-cresol, and an insecticide called Cannon's fruit protector, would all prove efficient remedies if systematically used, especially upon the young larvæ.

The observations of the past season upon the insect under consideration have brought out the following peculiarities: The very late hatching

and dispersion of the young; the unusual length of active larval life; the occurrence of both sexes upon the leaves; the fact that the females do not fix themselves until after impregnation, and, under certain not well-understood conditions, a very remarkable preponderance of males.

The Linden Leaf-Roller.—The only shade-tree pest of importance, not observed in this locality previous to the past season, was the above-named Pyralid (*Pantographa limata* Gr. & Rob.). This appeared on both the native and European lindens (*Tilia americana* and *T. europæa*) along the walks and on the lawns of many residents of Kirkwood, and attracted general attention by the peculiar manner in which it twisted the leaves. On the trees of the "Linden walk" in the grounds of Mr. A. S. Mermod the insect occurred in such numbers that almost every third leaf, of the European lindens especially, was thus rolled, and the trees reminded one of Christmas trees covered with candles.

The newly hatched larva begins its case by simply folding under a bit of the edge of the leaf, severing the folded part at the end toward the base, and feeding on the green tissue of the portion inclosed. After the first molt, it effects another roll and by a series of stitch-like bands of silk fastens it in place and continues the process until the entire leaf (of the European linden) or the apical two-thirds of our native species is included in the coil. During the day it feeds sparingly upon the included portions of the leaf, but at night, when it spins and folds, it also eats ragged holes in the adjacent leaves or gnaws their edges. The nearly full-grown larvæ sometimes desert the first case and form a fresh and very perfect one shortly before leaving the tree for pupation. Within this case the larva rests in slovenly fashion among a lot of sticky web and scattered frass. The larva and its case are described by Prof. Fernald in the *Canadian Entomologist* (vol. XVI, p. 26).

In the specimens examined this summer the form was rather subcylindrical than fusiform and tapered only slightly posteriorly, and the head and collar were more frequently brown than black. Prof. Fernald also says: "While the imago of *Pantographa limata* Gr. is a typical Pyralid, the larva is so very much like Tortricid larvæ, both in structure and habits, that I unhesitatingly referred it to the Tortricidæ till it emerged." This is true of the larvæ after the last molt or just before changing, but the younger larvæ have the somewhat slimy surface and other less definite characteristics which the experienced observer at once recognizes as peculiar to the leaf-feeding Pyralids. When ready for transformation, the larva cuts a circular hole through the side of its case and lets itself to the ground, where it forms from a leaf a spacious, oval tent which it lines with silk, or more frequently the leaf will be attached to the lower part of the trunk of the tree or some other flat surface and will then be in the form of an eggshell divided in half longitudinally and applied by the edges. In the rearing cages, these large, low tents were affixed to the glass by numerous stitch-like bands of silk, and the glass was so thinly coated with web that the larva or pupa within was but slightly obscured from view.

The pupa averages 16^{mm} in length, is rather stout for a Pyralid, of a shining red-brown color, sometimes tinged with olive. Pupæ were first observed on July 9, and the moths began to emerge on the 25th of the same month and continued coming out in the rearing cage until the 10th of August.

This species is one of the largest and handsomest in the group, having a wing expanse of from 1 to 1$\frac{3}{8}$ inches (25 to 35^{mm}), and being more lustrous and variegated in coloring than is usual among its leaf-feeding allies.

The second (or it may have been the third) brood of the larvæ appeared on the trees about the middle of September, and singularly enough from one to three of them, still very small, were often found in the large cones deserted by the preceding brood. In the rearing cages they developed very irregularly, one or two moths appearing early in November, while others that were, perhaps, somewhat underfed are still reposing in their cases unchanged.

No parasites were bred except a Tachinid of the genus Parexorista.

Spraying was not resorted to this year, but will be practiced should the insect again appear in injurious numbers, as it is evident from tests on a small scale that a very small proportion of Paris green in water is quickly fatal to it.

Insecticides.—In the Missouri botanical garden, when necessary to spray fruit or other trees, the arsenites were this year in many cases combined with the most approved fungicides, and I was assured that the latter were quite as effectual against vegetable parasites when thus associated, while the lime and copper compounds seem to prevent that scorching of the foliage which frequently attends the application of the simple arsenites and water. A number of nurserymen and orchardists of my acquaintance have used the same combination when spraying, and claim great success in it.

A preparation known as Cannon's fruit protector was tested against certain insects, especially Coccidæ, with good success. In odor and consistency, as well as in its effects, it differs but slightly from thymo-cresol, on which I have previously reported, and I do not think that it is in any way superior to the latter. It is in the form of a molasses-like fluid of which one part to eighty or one hundred parts of water are used, to be applied as a spray or drench, as a combined insecticide and fungicide. Delicate foliage was in some cases injured by it, appearing as though greased, and after a few days shriveled and dropped, and I would not recommend its use against caterpillars or Aphidids, but think it would prove a good repellant on the trunks of trees against borers, and might be advantageously applied to trees affected with bark-lice.

INSECTS OF THE SEASON IN IOWA IN 1893.

By Herbert Osborn, *Special Agent.*

LETTER OF SUBMITTAL.

Ames, Iowa, *October 28, 1893.*

Sir: I forward herewith a report on some observations of the season of 1893 referring to the general insect attacks of the season, and with more special reference to a few forms that are of unusual interest. Aside from the observations reported here a number of other species have been studied, but full reports can not be presented at this date, and they can be better treated in special papers.

During the season I have prepared two papers, one On the Methods of Combating Insects Affecting Grasses and Forage Plants, and the other On the Treatment of Parasites of Domestic Animals, presented at the meeting of the Association of Economic Entomologists, at Madison, both of which were in large part the results of studies that had been made with reference to the division work. Allow me here to express my thanks for many favors during the year.

Very respectfully, yours,

Herbert Osborn.

C. V. Riley,
U. S. Entomologist.

The season of 1893 has been somewhat exceptional in the nature of its insect attacks, a number of species usually inconspicuous becoming seriously abundant and attracting no little attention on the part of cultivators. This has been especially true of the clover-hay worm, the wheat-head army worm in some localities, the clover-seed caterpillar, and the horn fly. The first part of the season was rather cold and quite wet, so that insect injury, except that caused by the clover-hay worm in barns and stacks, did not attract attention. The latter part of the season, however, has been quite dry, amounting for a few weeks to a drought, and within this time insects have shown their presence in very destructive numbers. A somewhat detailed statement of the various species will be in order.

From the conditions present this season it is probable that we will have a pretty large number of grasshoppers another season, unless the occurrence of the blister-beetles and Bombyliid larvæ, which destroy the eggs, has been extensive enough to reduce their numbers.

On the Hatching of the Eggs of the Horse Bot-fly.—On September 19 I obtained a number of eggs of the common horse bot-fly, and from the

fact that two or three flies were at the time depositing eggs on the animal, it seemed probable that a good share, at any rate, of those obtained had been recently deposited. It occurred to me to make some observations on the time and conditions when these eggs would hatch, and the following record is the result: On September 23, four days after collection, the eggs, when moistened, showed distinct dark bands with rows of black spines upon the segments, indicating a well developed condition of the embryo, but there was no tendency to hatch and the egg when opened showed the embryo to be only slightly active, its movements being slow, and it would appear that it was not really ready for hatching at that time. An effort to hatch them by rubbing was not made at this time but the eggs opened by picking off the cap. On the following day, September 24, the eggs previously moistened did not hatch, but one egg, upon being moistened and rubbed for some time with the end of the finger in a manner to simulate the action of the horse's tongue, was hatched, and adhered to the finger. This specimen was fairly active, especially the hinder portion of the body. This must have been at least five days after deposition and, of course, may have been longer than this, as some of the eggs may have been deposited some days previous to the time of collecting. On September 25 the two eggs which were first moistened but not rubbed were still unhatched, and it would appear from this that moisture alone is insufficient to produce the hatching, at least during the earlier time following deposition. On the next day another egg was hatched by moistening and rubbing and by also picking the cap of the egg with a pin. The rubbing alone did not succeed in hatching it, although continued for a long time, but when the lid was picked with a pin the larva appeared active and it would seem perfectly capable of all movement necessary for migration to the stomach. On September 27 another specimen was hatched, but this was also hatched with difficulty, the cap being removed finally by slight pressure with a needle point, the larvæ, as in previous cases, appearing active. On September 28 another egg was hatched in the same manner as the preceding one, the cap being removed with difficulty but the larva active. It would seem from this that for at least ten days the hatching occurs with difficulty and if these were average specimens it would hardly be possible with the ordinary movement of the tongue to secure the release of the larvæ. Some days elapsed before another effort was made, but on October 21 another egg was tried and this one hatched almost immediately upon being touched with the moist finger, the larva adhering to the finger and wriggling about with great activity, so that it would certainly have had every opportunity to find the conditions for its survival. On the same day two other eggs were opened, the lid being removed very quickly by being moistened with the finger, but the larvæ from these two eggs were inactive, apparently dead, and this would seem to confirm the view that the larvæ die without issuing or breaking the cap from the egg unless moisture or rubbing is

applied. Again, on October 26, two or three eggs were used, each of which gave off the cap very readily, but in none of them did I find any active larvæ, although one of the larvæ seemed to be fresh and showed very feeble movement. October 27 one egg hatched as before and gave a larva which appeared inactive. Another, hatched at the same time, appeared inactive at first, but, upon the addition of a drop of saliva, showed at first a slight amount of movement at the head end, being most apparent in the hooks and later quite decided contractions appeared in the forward part of the body, the larva becoming in a short time sufficiently active so that there would seem to be no difficulty in its securing proper conditions for development and ability to attach itself to the mucous membrane of the alimentary canal had it been set free upon the horse's tongue.

October 28 seven eggs were opened by means of moisture and rubbing as heretofore, and these all proved to be inactive, three of them thoroughly plump, but not recovering when placed in a drop of moisture, while the others were shriveled and two of them adhered to the shell.

I also found among the remaining eggs one from which the larva was partially free, the cap of the eggshell adhering to the front end of the larva and the larvæ wriggling about actively, the tail portion only being connected with the shell.

One or two other eggs had been noticed from which the caps were removed, and these had probably hatched by their own efforts. This would seem to show that it is possible, although not a normal habit, for the embryos to push the egg cap off and escape without assistance.

Summing up the results of these observations, which were not as complete as might be desired, it seems that we may, with considerable certainty, reach the following conclusions. Some difference, due to the changing conditions of moisture, may be possible under field conditions, the conclusions being strictly applicable only to the conditions under which these eggs were kept:

(1) That the eggs of the horse bot-fly do not hatch, except by the assistance of the horse's tongue.

(2) That hatching does not ordinarily occur within ten or twelve days and possibly longer, or, if during this period, only on very continuous and active licking by the horse.

(3) That the hatching of the larvæ takes place most readily during the third to fifth week after deposition.

(4) That the majority of the larvæ lose their vitality after thirty-five to forty days.

(5) That larvæ may retain their vitality and show great activity upon hatching as late as thirty-nine days after the eggs were deposited.

(6) That it is possible, though not normal, for eggs to hatch without moisture or friction.

(7) That in view of these results, the scraping off of the eggs or their removal or destruction by means of washes will be very effective, even if not used oftener than once in two weeks during the period of egg deposition, and probably that a single thorough removal of the eggs after the period of egg deposition has past will prevent the great majority of bots in gaining access to the stomach, or at least so large a proportion, that little injury is likely to occur.

The Horn Fly.—This is the first season in which *Hæmatobia serrata* has proved troublesome in this vicinity. Reports late last year indicated some trouble in the eastern portion of the State, and in Kansas it was reported much farther west, but was not observed in this particular locality. I have been informed, however, by some stockmen that it was seen late in autumn. The present season it appeared in large numbers in the first part of July, numbers being sufficient to seriously annoy stock, and from that time on the pest has been very plentiful and troublesome.

The Clover-hay Worm.—This species was one of the conspicuous pests of the season, specimens being received from different parts of the State and reports from other localities sufficiently to show that the clover hay quite generally throughout the State and in adjacent localities has suffered largely from its attack. The injury has been of the characteristic form, the lower portions of the haymows and stacks being eaten, filled with webs and excrementitious matter, entailing a considerable loss. Aside from *Pyralis costalis*, the *Pyralis farinalis* has been quite abundant, appearing in large numbers in some of the barns, and it is pretty certain that a considerable portion of the injury may be referred to that species. Judging from the abundance of the moths in certain cases, it would seem to be the more abundant form, but in a number of cases where specimens have been received the larvæ were of the *costalis* form and proved upon breeding to be that species. There is probably no difference in the habits of the two forms, so far as their clover-feeding habit goes, that would necessitate any difference of treatment. I have, in a few cases, recommended the use of bisulphide of carbon for this pest with special precaution as to its use on account of inflammability of the liquid, and while I have not had the opportunity to test it personally, nor receive reports from any who may have tried it at my suggestion, I am confident that it could be used for the destruction of the larvæ, and that by this process barns could be freed from the pests without the necessity of the cleaning out of the old hay and burning the webbed portions, a process which involves considerable labor and is sometimes quite inconvenient to adopt.

Clover-seed Caterpillar.—This species, *Grapholitha interstinctana*, has received attention during the last two or three years, but its increased abundance the present season makes it worthy of still further mention. It has been forwarded from different localities and has certainly

attracted more attention from farmers this season than at any time heretofore. So plentiful was it during the latter part of the summer that there seemed no possibility of a profitable crop of clover seed, and where it occurred in abundance the recommendation was made that the clover be cut before the larvæ had matured or else pastured heavily, with the hope of destroying as many of the larvæ as possible and preventing a late fall brood of this species, which feeds largely upon the leaves and at the base of the stems and later hibernates, to mature in the spring.

The Sod Web-worm.—The sod web-worm, *Crambus exsiccatus*, was more plentiful the present season than it has been at any time since 1887, and judging by the large numbers of moths that appeared at lights during August and September, there must have been quite extensive injuries from them.

The Wheat-head Army Worm.—Attention has been called to this species, *Leucania albilinea*, in nearly every report during the past few years, but it has this season appeared more numerously and attracted more attention than at any time since the year 1887, and the distribution of the species in the State has been different from its occurrence in previous seasons. The greatest amount of injury, judging from reports, has been in the northeastern quarter of the State, particularly in the line of counties running west from Dubuque to the middle of the State.

As in previous years, the reports have been in regard to injury to timothy, and in no case have I learned of attacks upon wheat or other crops, although it is not at all improbable that such crops have been attacked, but injury has not been noticed. As the species has not been abundant in the immediate vicinity of Ames, I have had no opportunity to make direct investigations or to attempt immediate measures. The varied food plant of the species, and particularly its inconspicuous nature during the autumn months, make it difficult to suggest remedies that are in any great degree successful or which could be considered worthy of strong recommendation. In general, the recommendation has been given that as soon as the injury is manifest upon timothy, and if the worms are present in any considerable numbers, that the timothy be cut immediately and saved for hay, since delay in the matter would mean a loss of the seed crop and also loss of the hay. Even at the time the worm becomes apparent in its stripping of the timothy heads the hay is usually past its prime for forming the hay crop, but it is much more profitable to save it then than to lose it entirely. This method would, of course, be inapplicable in wheat fields, but, as already stated, the injury from this species to the wheat in this section has not at any time seemed serious. It is probable that the maintenance of trap lights at the proper time would be quite effective, but the difficulty of getting farmers to make use of any measures except at the time when the damage is apparent, renders this of little avail.

The Leaf-folder—During the latter part of the summer my attention was called to a serious depredation of the leaf-folder in some nurseries near Des Moines. Examination of the leaves showed the presence of large numbers of the larvæ, with a considerable number of pupæ, and from these pupæ I obtained, during the early part of October, considerable numbers of the winter form of the leaf-folder (*Teras minuta*). The species has been somewhat prevalent during the past few years, but this season became much more destructive and caused considerable damage to several acres of yearling trees. The indications at the time my attention was called to them were that the use of poison would be effective for the larvæ still immature, but they were so rapidly maturing that it seemed hardly desirable to adopt such measures for the present season. Both pupæ and larvæ were in such condition, however, as to be destroyed by pinching, and this was recommended on account of the benefit it should give for the coming season.

The Leaf Skeletonizer (*Pempelia hammondi*) occurred in considerable numbers in the nurseries where the leaf-folder was destructive, and was responsible, probably, for about 20 to 25 per cent of the damage. Had the injuries been noted somewhat earlier practically all the damage done by this species could have been avoided by a spraying with London purple or Paris green, but at the time mentioned the season had so far passed that it seemed impracticable and of little use to make applications.

Nomophila noctuella.—In two of my previous reports I have called attention to the great abundance of this pyralid moth, and suggested the probability of its being a destructive species in pastures and meadows. The immature stages have, however, not been observed, and no opportunity has been presented for giving the species a special study. Last season Mr. E. P. Felt, at Cornell University, bred the larvæ, and presents in the *Canadian Entomologist* (vol. XXV, p. 129) a summary of the life history of the species with figures of the larva and adult. He found it to feed upon clover primarily and also upon grass, and his observations seem to establish the economic importance of the species. Evidently this species is distributed very generally throughout the country, and judging by the abundance of moths in this locality it must rank as one of the particularly destructive species. According to Mr. Felt, the collection of adults at lights would be of little avail in this species, as those which gather at lights are for the most part males. In the related species belonging to the genus Crambus I have shown that the individuals coming to lights are in a large part females loaded with eggs, and it seems to me that it is desirable to obtain still more complete records as to the individuals attracted to lights before a final conclusion is reached as to the value of this method. The difficulty of attacking the insect in any other manner, except by plowing, makes the use of lights, if in any degree successful, an important method of destruction.

The Clover-seed Midge (*Cecidomyia leguminicola*).—This pest has caused considerable trouble during the season, although I believe it is subordinate to the clover-seed caterpillar mentioned elsewhere. Samples of clover heads have been received from various localities in which the midge larvæ were abundant, and they have doubtless been responsible for considerable losses. The farmers of the State seem impressed with the importance of the species and are making efforts to control it. The plan of cutting early for the first crop does not seem to meet with so much favor with many of them as the plan of pasturing the clover fields during the spring months so as to prevent the development of a spring brood of midges. This method presents some advantages and I am inclined to think it will prove most advantageous if the clover is allowed to head before turning stock upon it, so that such midges as appear may deposit eggs, and then by turning on a good number of animals the heads may be devoured before the larvæ have had time to develop. When the crop is cut for hay there is, of course, some danger that the more advanced larvæ may be shaken from the heads and pupate, thus producing the second brood of midges. Moreover, the farmers are adverse to cutting for hay early on account of the smaller crop and the interference with other farm work.

REPORT ON INSECTS INJURIOUS TO FOREST TREES.

By A. S. PACKARD, *Temporary Field Agent.*

LETTER OF SUBMITTAL.

PROVIDENCE, R. I., *October 18, 1893.*

SIR: I forward this day a report on the work done the past season in Maine and Rhode Island. Notes were also made on other insects, and partial life-histories recorded which are not yet sufficiently complete for publication. In accordance with your instructions I spent a portion of the season, most of June and the latter part of September, in Providence, and the months of July and August in Maine, and early part of September in New Hampshire.

Respectfully, yours,

A. S. PACKARD.

C. V. RILEY,
U. S. Entomologist.

Notwithstanding the uniformly severe and prolonged winter of 1892–'93, during which there seemed to have been fewer sudden alternations of severe cold and thaws than usual, there was in the summer succeeding a remarkable dearth of insect life, especially of caterpillars and other larvæ which feed exposed on the foliage of trees and shrubs. I never knew such a scarcity of these insects, and this state of things, I am told, prevailed to a greater or less degree throughout New England.

The Spruce Worm and Larch Worm.—Two subjects of interest in connection with my work in former years attracted my attention. These were the effects of the invasion of the spruce worm (*Tortrix fumiferana*) and of the attacks on the larches or hackmatacks of the larch worm (*Nematus erichsonii*).

The region on the shores of Casco Bay, in which I spent the months of July and August, and which in 1878–'87 was ravaged by the Spruce Worm, as described in the Fifth Report of the U. S. Entomological Commission, was greatly changed in appearance since 1887. During the past few years the former unsightly aspect of the shores, including portions of the mainland, as well as the inner islands, have been most decidedly and very pleasantly changed by the rapid growth of young spruce and firs which had sprung up since the old growth had been removed, with the result that what were formerly bare and unsightly areas are now fresh and green tracts, with the promise of soon becom-

ing thriving woodland, owing to the rapid growth of the young trees. In one place in particular, on the new wharf road in Brunswick, of which photographs were taken in 1883, and which are reproduced as Plates XIII and XIV of my report, the new growth of spruces and firs has within ten years completely changed the aspect of the fields and woodlands at that spot. And so it is with an extensive tract of land on Birch Island, devastated by this worm about ten years previously. These coniferous trees grow nearly a foot a year, under favorable conditions, and thus rapidly cover and conceal old stumps, piles of trash wood and fallen trees, as well as places more or less bare of vegetation.

It is also to be observed that neither the caterpillars nor moths of the species have been observed at or about Casco Bay since 1883 or 1884, none of the worms being detected on the trees, and none of the moths being taken by the net or captured at light.

The larches or hackmatacks in Maine have in general recovered from the attacks of the larch worm, which was so abundant a few years ago. No specimens either of the worm or of the sawfly were collected or observed during the past two years. While a few old trees died, the younger ones, or those not too much ravaged, appear to have leaved out and to have recuperated.

The Fir Leaf-sheaf Worm.—During the past two or three years the firs on the shores of Casco Bay at Brunswick, Me., have been disfigured in an unusual way by the larva of a Tineid moth, which has been determined by Prof. C. H. Fernald to be *Blastobasis chalcofrontella* Clem. My attention was called to the work of this caterpillar during the end of June and in July, 1891, the worms occurring as late as July 15. The terminal branches of the trees bore some dead red "needles" or leaves, which, however, had not been gnawed off by the worm. On the under side of such twigs or small branches were masses of castings or excrement, enveloping what seem to be the swollen or hypertrophied bases or sheaths of the leaves, and which look like flower buds. They are about a fifth of an inch long, forming masses about an inch in length. These empty capsules were sewed together by a few silken threads, and among them the little caterpillar resides. It does not bore into the twig itself, which is green and fresh, but the tree is none the less seriously disfigured by its attacks. As the worms did not occur later on in the season I judge they begin their work in the spring, or at least in May. Some that were found July 15 finished their transformations towards the end of the season, the moth being found dead in the breeding box in May of the following year. Whether it emerged before the winter or not I can not state.

A small Tortricid larva was observed at Brunswick, Me., early in the summer of 1890, and in 1891 at work on the end of the twigs of the spruce. It cuts off the needles for a space of about an inch in length and spins a web next to the twig by which the faded red needles are attached to the twig. When about to transform it spins a rude,

long, slender, oval cocoon covered with pellets of excrement, within which it changes to a chrysalis, the cocoon being situated under and among the dead, reddish leaves. The larvæ were observed July 1, and the moth appeared the following spring.

The Fourteen-flapped Geometrid.—Several caterpillars of this species from which I bred moths like *Aplodes coniferaria* occurred on witch hazel, *Hamamelis virginica*, living among the tawny, yellowish-brown leaflets of the ends of the shoots, September 8, at Brunswick, Me. Its shape, markings, and color are such as to assimilate it to the peculiar small yellowish leaflets at the end of the flower-twigs, and to enable it to easily avoid the attacks of birds. It is an excellent example of protective mimicry. It changed to a chrysalis in a thin cocoon, and the moth appeared in the breeding cage May 10 of the following year. It probably lays its eggs in June on the opening buds or leaves.

It is probable that my *Aplodes coniferaria* is but a small form of *A. mimosaria.*

Notes on Lepidopterous Larvæ attacking Forest Trees.—From the chestnut I have reared *Acronycta hamamelis* Guen. It spun a thin but regular cocoon, and changed to a pupa October 7. Also from the yellow birch, the pupa occurring September 15–20, *Acronycta ovata* Grote. *Acronycta grisea* Walk. was bred from the willow and poplar.

On the tupelo at Providence I found, September 28, the larva of *Catocala elonympha* Hbn. The caterpillar is pale gray, resembling in markings and color a piece of the twig of this tree. It has no very distinctive markings or prominent warts or humps. It spun a thin white cocoon and pupated October 4, and the moth emerged in the breeding box on May 15 ensuing.

From the choke cherry I have had *Eutrapela transversata* Dr., the moth appearing August 24.

From the willow I have reared at Brunswick, Me., *Boarmia crepuscularia*, the moth appearing August 30, the pupa having been found August 8.

From the chestnut at Brunswick, Me., I took, August 23, a pupa of *Acidalia insularia* Guen., which disclosed the moth on the 27th of the same month. I also collected from a maple, September 6, at Brunswick, Me., the pupa of an *Eupithecia* near *luteata* in the shape of its wings and markings, but yet apparently distinct.

The larva of *Deilinia erythemaria* occurred at Brunswick, Me., not uncommonly on the willow and poplar, the moth appearing August 6.

Hypena scabra Hbn. was bred from the poplar, the moth appearing September 5.

The following Tortricids were reared:

The pupa of *Teras ferrugana* Schiff. was found on a leaf of *Betula populifolia* September 20, the moth appearing October 2.

Cenopis reticulatana Clem. The larva of this leaf-roller, which is recorded by Miss Murtfeldt (Fernald's Catalogue of described Tortri-

cidæ, p. 20) as feeding on the oak, Osage orange, maple, persimmon, and pear, was discovered July 12–16, feeding on *Apocynum androsæmifolium* or dogbane, at Brunswick, Me. It is pale greenish, with no stripes or other markings. The head is honey-yellow. On each abdominal segment, except the last two, are four dorsal whitish piliferous tubercles, the hairs arising from them being rather long. It pupated July 19, and the moth appeared August 7. It is well represented by Robinson's figure 34 (Trans. Amer. Ent. Soc., Feb., 1869).

Teras hastiana L. was reared from a larva found feeding on the spruce July 30, at Brunswick, Me. The caterpillar is green with a dark head.

The following Tineid moths were also reared:

Gelechia inscripta Wlsm. The larva was found feeding on the oak at Brunswick, Me., September 1. The head and prothoracic shield of the larva are dark amber color, the latter blackish in hind edge. Body dark green, transversely ringed with red lines ending on a lateral dot, the reddish bars being widest on the second and third thoracic segments. It pupated about September 8 or 9, and the moth was found dead in the breeding box May 10 ensuing.

Coleophora cinerella Cham. A specimen of the moth was bred from a larva found on the poplar at Brunswick, Me. The larva was not described, but the sack is cylindrical, not flattened as usual, and the posterior end is compressed, somewhat turned up, the anterior end being cylindrical and tapering nearly to a point. It is of the color of a dead, dry leaf. The larvæ occur early in July, the moth appearing July 14.

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